Journal of the Bombay Natural History Society

Vol. 61, No. 1

Editors
H. SANTAPAU, S.J., & ZAFAR FUTEHALLY

APRIL 1964

Rs. 15

NOTICE TO CONTRIBUTORS

Contributors of scientific articles are requested to assist the editors by observing the following instructions :

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EDITORS,
Journal of the Bombay Natural History Society.

91, Walkeshwar Road,
Bombay 6-WB.

VOLUME 61, NO. 1—APRIL 1964

Date of publication : 25 August 1964

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CORRECTION SLIP

In Vol. **61**, in the list at pp. 284 to 293 :

1. In the column of recorded distribution insert 'Calcutta' against Serial Nos.

15.	*Hippotion boerhaviae*	43.	*Stauropus alternus*
16.	*H. celerio*	48.	*Altha nivea*
18.	*Macroglossum belis*	64.	*Creatonotus emittens*
24.	*Theretra alecto alecto*	73.	*Nola major*
27.	*T. clotho clotho*	105.	*Fodina stola*
30.	*T. nessus*	113.	*Leucania irregularis*
31.	*T. oldenlandiae*	131.	*Plusia jessica*

137. *Pseudelydna rufoflava*

2. In Serial No. 98. for, '*Cosmophila erosa* Hubn.' read '*Cosmophila flava* F.', and in the column of recorded distribution insert: '*C. erosa* Hubn. occurs only in the New World.'

3. Correct the Serial Nos. given below as follows :

19. for '*Marnmba dyras*', read '*Marumba dyras*'
66. for '*Rhodogastrea frederici*', read '*Rhodogastria frederici*'
113. for '*Leucanea irregularis*', read '*Leucania irregularis*'
114. for '*Leucanea* sp.', read '*Leucania* sp.'
141. for '*Rhesala imperata*', read '*Rhesala imparata*'

ERRATA

In Vol. **61** (2): 402-409, in paper entitled 'Floral asymmetry in Malvaceae', at p. 404 in lines 5 to 9 from top, for the two sentences 'Of the 34 species . . . . . . a significant difference.', *substitute* :

> Of the 34 species, 19 have excess left-handed flowers, and of these, the χ^2 values for only two species show a significant difference from equality. None of the 15 species having excess right-handeds (excepting *Pavonia odorata* which may be ignored on account of smallness of sample size), as is obvious from the Table, shows a significant difference.

JOURNAL
OF THE
BOMBAY NATURAL HISTORY SOCIETY

1964 APRIL Vol. 61 No. 1

One nest of *Sceliphron madraspatanum* (Fabr.) (Sphecidae; Hymenoptera)

BY

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(*With* 18 *figures in four plates*)

CONTENTS

I. INTRODUCTION

This paper describes the building of a nest by one female of the species *Sceliphron madraspatanum* (Fabr.), during 14 days, on 12 of which it is unlikely that a visit was unnoted. Visits to the construct and absences were described and timed to the nearest second. Such a crudely biometrical approach, which we do not think has been attempted before, we hope compensates for the qualitative gaps in the record due to the observers' ignorance of the Hymenoptera at the time the opportunity to collect these data presented itself.

The record was made by H.S. and K.R.D.; S.D.J. made the statistical analysis and the excavation and interpretation both of this nest

and corpses, and of that found in 1961. Professor J. B. S. Haldane assisted with both the collection and the analysis of the data. Dr. J. van der Vecht of Leiden identified our specimens, and with Dr. E. White of Liverpool and Dr. Kenneth W. Cooper of Dartmouth, New Hampshire, introduced us to the literature. We wish to thank all these collaborators.

II. The sequence

The nest was built between 15-7-1960 and 28-7-1960 in a house just north of the Calcutta municipal boundary. It is in a rapidly developing industrial area but still surrounded on all sides by waste grassland intersected by ditches. In July, which is during the first half of the monsoon, all soil is almost continuously muddy. A small varnished wooden table 60 cm. high and 75 × 33 sq. cm. in area stood against the west wall of a first floor (in the English sense, not ground floor) room about one metre from a permanently open window in the north wall. The nest was built about 7 cm. from the north-east corner of the table immediately under the horizontal table top on the vertical bar of wood supporting this, on the side of the table facing east. A chair stood in the NW. corner of the room between the table and the window. During the period of observation the time of sunrise advanced from 05.01 to 05.06 and sunset retreated from 18.24 to 18.19 Indian Standard Time. Noon, therefore, was about 11.42. The temperatures were not recorded in the room of observation; but in a similar shaded room, but permanently open to the south, the maximum and minimum temperatures recorded between 12.00 and 13.00 on 15/7 for the last 24 hours were 28.8° and 26.3°C. They were not recorded on 16/7 and for the rest of the period of observation were always between 30° and 31° and 27.7° and 28.9° respectively.

15/7. Sometime after 09.00 a reader in the above-mentioned chair was disturbed by an insect repeatedly flying across the page of the book. Note taking was begun at 09.24. After two visits it was realized that intervals must be recorded to the nearest second. When, after about 4 minutes, the table was inspected during an absence, a smooth layer of mud, in the centre of which was a small cup, was seen. Records were kept of the rest of the construction of the walls of cell I, which was finished at 10.06.59, i.e. 59 seconds after 10.06 a.m. (Fig. 1.). No further visit was recorded until 11.44, when watching was discontinued. At 11.46 or 47 the nest was again inspected, and at 11.48.45 the wasp returned and entered the tube completely.

Oviposition is thought to take place during this complete entry. No load was seen on 15/7, though comparison with subsequent

cells makes it virtually certain that the wasp entered carrying a spider. Watching was recommenced, the observer sitting opposite the nest. The observer sat in this position for all subsequent observation of the nest. Six further visits were observed, and no loads were seen. It seems possible, on interpreting the actual wording of the notes afterwards, that loads were brought on three of these. That no spiders were seen is interpreted as due to the observer (H.S.) expecting the wasp to bring Lepidopteran caterpillars and therefore being insufficiently attentive to observe less conspicuous objects. Two visits were occupied with closing the cell with mud making a *concave* lid. At 14.47, an hour after the second lid building visit, watching was discontinued for the day. In the evening no further construction was noted, so only visits for inspection can have been missed. The afternoon was sunny.

16/7. At 07.47 the wasp was noticed flying round the nest. At 07.52 disciplined observation was begun. The concave lid was already removed from cell I. At 08.09.24 the animal settled for the first time. After 3 more visits, during which no load was seen, one spider was introduced. Then the cell was sealed with a *convex*, almost knob-like, smooth lid made with mud brought on 3 journeys, and 2 loads of mud were daubed on each side of it immediately. The wasp then smoothed mud on the table immediately below cell I. This smoothing stopped for a period of over half an hour. It recommenced, and upon the smoothed mud she built cell II (Fig. 2). During this period we first noticed that the cell walls were made by bringing balls of mud which were placed in the centre of the existing arch and rolled out towards the surface of the table with the mandibles and the 1st pair of tarsi. One of each pair of appendages worked against the inner and one against the outer surface of the cell, therefore they made little ridges in the soft mud of the temporary margin, at right angles to the line in which the balls were being extended. After the first rolling out, the newly applied mud was reworked by the same movements several times up to the vertex of the arch and down to the floor. The balls were rolled out first to the right and then to the left. Therefore strips were added to each wall more or less alternately. The alternation with which the two sides of the wall were built was almost complete for cells II and III which like cell I lay flat upon the vertical surface of the table. Later cells were built behind these first three, propped up against them so that they were at an angle with the vertical support of the table top. These later cells were fitted into the uneven foundation, and their walls were curved to fit awkward niches by rolling out several balls parallel to one another on the same side of the vault one after another. The cell wall was always begun on a *foundation* of mud smoothed on the table, and from the beginning of the cell itself, the walls were built

by rolling out loads in an alternating way. Each cell was thus an arched vault, the whole floor of which in the early cells, and of the base of the later cells, was mud smoothed upon the vertical wood, but the floor of most of the length of the later cells was a previously made part of the construct. When a cell was about 2.2 cm. long the mud balls were rolled in such a way that the floor space left between the walls gradually narrowed until the two walls met and a short cylindrical neck was formed, finished off with a rim. The cells are thus about 0.5 cm. less in length than those of the species described by Fabre which Berland (1925) identified as *S. spirifex*, and the spiders introduced are correspondingly smaller (Fabre 1924) but our animal similarly buzzed during building. After rolling each ball on to the cell, the wasp swept it vigorously with her antennae, both inside and out, but she never applied any pressure or moulded the mud with the antennae. She repeatedly cleaned her antennae and mouth-parts with her front tarsi. Some of these details are from notes taken during later periods of cell building. It will be noticed from Table III that the fewest wall building visits are recorded for cell II. This is perhaps because wall building was not at first distinguished from foundation building. While fetching mud the wasp did not always fly in the same direction when leaving the window, nor did she arrive from only one direction.

After 391 seconds the wasp returned with a spider, entered cell II, abdomen first, and entered it completely. She emerged head first and flew. The spider was dragged out hanging from her by its silk, fell to the ground and was retrieved by the observer. It did not move and was preserved. The wasp returned after 2316 seconds, again with a spider, and again she entered backwards and completely. On 22/7 again she pulled out the spider after this backwards entrance to cell VII, and again repeated the same procedure on her next visit. She entered both backwards and entirely only once into all the other cells. All other spiders were thrust in with the head and forelegs, the abdomen being clearly visible throughout the process. No spider inserted in this way was ever dragged out, though in filling cell VII one was too large and escaped, only to fall motionless to the ground immediately. The complete entrance was the only activity on the nest in which the abdomen was completely hidden from the observer for more than an instant. We assume the oviposition to take place during this complete entrance, both because of its quite discrete difference from other spider-bringing visits and because previous describers of this and other species of *Sceliphron* assume that the eggs, which are attached to a spider, are laid inside the cell and not at capture, or during transportation to the cell. If this interpretation is correct this individual of *S. madraspatanum* like those described by Horne

(1872) and Dutt (1913) was unlike *S. caementarium* (the Peckhams 1905 and Shafer 1949) but like *S.* (*Pelopaeus*) *spirifex* (Fabre 1924) in laying her egg invariably on the first spider. Oviposition seemed to miscarry surprisingly often, but the animal seemed able to compensate for these miscarryings by repeating the process. On 16/7 watching was discontinued from 11.47 to 14.00. When the observers returned, cell II was sealed with a concave lid, and cell I was covered with a shapeless mass of roughcast which was dark and therefore damp when first seen (Fig. 3). Watching was continued until 18.07, and though the afternoon was sunny, only one visit, which was without a load, was observed. Probably less than 40 visits were missed.

During the whole 14 days of observation 91 visits were observed, during which we are certain the animal neither brought provisions nor altered the construct. These 91 are called *inspections*. During them she swept the construct with her antennae, which she wiped with her first pair of tarsi at intervals. This *sweeping* was also performed during almost all other visits. The antennae were swept up and down the edges and the interior of the half-built cells, and, we think, wiped more often than usual with the feet during this activity. More than half of these inspections took place while the cell was being provisioned, when the antennae and sometimes the head and thorax were thrust into the open cell. The wasp rarely entered an open cell. This sweeping would seem to have been a scanning activity by which the wasp received stimuli, or information, from the nest. The wiping with the tarsi may have merely cleaned the antennae, but may also have been important sensorily, by bringing particles picked up by antennae into contact with sense organs on the legs.

17/7. From 17/7 we in turn attempted to watch throughout the possible working day of a wasp; and if any visits were missed, they must have been visits of inspection only. The 2nd and 3rd columns of Table I give the time of the observer's arrival and the wasp's first arrival respectively. Columns 16 and 17 give the corresponding times of the wasp's and the observer's last departure. On 17/7 the animal swept the construct for less than 2 minutes of the first visit, paying special attention to the concave lid of II but also to the undaubed table top. Then she bit small fragments of mud from around the edge of the concave lid. She continued this with 4 pauses, one of 3 minutes, until the lid fell off as a little disc. She then swept inside

TABLE

VISITS OF *Sceliphron madraspatanum*

Date	Watch begun	1st arrival	First inspec-tions	Foundation	Wall	Oviposition	Prey	Doubtful prey
1	2	3	4	5	6	7	8	9
15/7	—	—	*?*	x on I	x on I	—	—	—
	09.24	—	—	—	25(+2) on I	—	—	—
	—	—	*?*	—	—	—	—	—
	11.47	11.48.45	—	—	—	1 in I	—	3 in I+*3*
	—	—	—	—	—	—	—	—
16/7	—	—	*?*	—	—	—	—	—
	—	—	?	—	—	—	? in I	—
	07.30	08.09.24	—	—	—	—	—	5 in I
	—	—	—	—	—	—	1 in I	—
	—	—	—	9 on II+*3*	22 on II	2 in II	—	—
	—	—	—	—	—	—	? in II + *?*	—
	14.00	14.44.50	—	—	—	—	—	—
17/7	06.14	09.13.22	*0*	—	—	—	—	—
	—	—	—	—	—	—	3 in II +*3*	1 in II+*2*
18/7	06 52	09.07.03	*0*	—	—	—	—	—
	—	—	—	—	—	—	3 in II + *8*	—
	—	—	—	13 on III	24 on III	—	—	—
19/7	07.15	08.48.50	*2*	—	—	1 in III	4 in III + *2*	1 in III
	—	—	—	5 on IV	27 on IV	—	—	—
20/7	07.12	07.54.25	*2*	—	1 on IV	1 in IV	2 in IV +*2*	2 in IV
	—	—	—	1 on V	—	—	—	—
21/7	06.43	07.07.06	*1*	—	—	—	—	—
	—	—	—	19 on V+*1*	29 on V	1 in V	8 in V+ *2*	2 in V
22/7	06.13	07.04.03	*1*	5 on VI	25 on VI	1 in VI	5 in VI + *2*	—
	—	—	—	11 on VII+*1*	26 on VII	2 in VII	1 in VII	—
23/7	06.11	08.07.13	*0*	—	—	—	—	—
	—	—	—	—	—	—	3 in VII+*2*	3 in VII
24/7	06.30	07.41.35	*1*	—	—	—	—	—
	—	—	—	1 on VIII	30 on VIII	1 in VIII	11 in VIII+*3*	1 in VIII
	—	—	—	2 on IX+*1*	25 on IX	—	—	—
25/7	06.23	07.29.25	*1*	—	—	1 in IX	1 in IX+*4*	—
	—	—	—	4 on X	—	—	—	—
26/7	06.23	07.08.17	*1*	—	—	—	—	—
	—	—	—	—	—	—	7 in IX +*4*	1 in IX+*1*
	—	—	—	10 on X+*1*	29 on X+*2*	—	—	—
27/7	06.10	07.31.30	*1*	—	—	1 in X	4 in X + *7*	—
28/7	06.39	?	*?*	—	—	—	—	—
	—	—	—	—	—	—	2 in X + *5*	—
	—	—	*10*	80 *7*	263(+2) *2*	12	51 spiders *44* +3 flies +1 spider escaped	19 *6*

NOTE. Numbers in brackets visits counted but not timed. Numbers in italics inspections are listed separately.

I

(Fabr.) to nest under construction

Concave lid	Removal of lid	Convex lid	Daub	Smooth	Last inspections	Last Departure	End of Watch	Totals	
10	11	12	13	14	15	16	17	18	
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	10.06.59	11.44	—	—
—	—	—	—	—	—	—	—	—	—
2 on I	—	—	—	—	—	13.46.30	14.47	—	—
—	—	—	—	—	*?*	—	—	31(+2)	*3*+ x
—	x from I	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	5 on I	—	—	—	—	—	—	—
—	—	—	—	—	—	11.45.37	11.47	—	—
x on II+*?*	—	—	x	—	—	—	—	—	—
—	—	—	—	—	*1*	14.46.05	18.07	44	*4*+ x
—	1 from II	—	—	—	—	—	—	—	—
2 on II+*1*	—	—	—	—	*0*	14.29.20	18.15	7	*6*
—	1 from II	—	—	—	—	—	—	—	—
—	—	7 on II+*2*	29	1	—	—	—	—	—
—	—	—	—	—	*0*	16.51.38	18.21	78	*10*
—	—	6 on III	—	1	—	—	—	—	—
—	—	—	—	—	*1*	17.20.59	18.46	45	*5*
—	—	8(+1) on IV+*2* (+*1*)	12	2	—	—	—	—	—
—	—	—	—	—	*0*	14.47.11	18.23	29(+1)	*6*(+*1*)
—	—	1 on IV	32(+1)	13	—	—	—	—	—
—	—	12 on V	—	—	—	16.23.45	18.46	117(+1)	*4*
—	—	10 on VI	5	1	—	—	—	—	—
1 on VII	—	—	80+*3*	34	*0*	17.14.30	18.32	207	*7*
—	1 from VII	—	—	—	—	—	—	—	—
—	—	4 on VII+*1*	—	—	*0*	10.40.46	18.45	11	*3*
—	—	3 on VII	1	—	—	—	—	—	—
—	—	6 on VIII	1	—	—	—	—	—	—
—	—	—	—	—	*0*	15.53.28	18.32	82	*5*
2 on IX+*1*	—	—	—	—	—	—	—	—	—
—	—	—	57+*4*	4	*2*	17.29.31	18.43	69	*12*
—	1 from IX	—	—	—	—	—	—	—	—
—	—	9 on IX	6	—	—	—	—	—	—
—	—	—	—	—	*1*	17.01.08	18.32	63	*10*
2 on X+*1*	—	—	53+*1*	13	—	15.46.32	18.30	73	*10*
—	(+1)+1 from X	—	—	—	—	—	—	—	—
—	—	—	—	—	—	11.39.31	18.34	3(+1)	*5*
9 *3*	4 (+1)+ x	71(+1) *5*(+*1*)	276(+1) *8*	69	*5*	—	—	—	*90*(+*1*)

immediately before and during relevant activity, except for first and last inspections of day which

TABLE I

VISITS OF *Sceliphron madraspatanum* (FABR.) TO NEST UNDER CONSTRUCTION

Date	Watch begun	1st arrival	First inspections	Foundation	Wall	Oviposition	Prey	Doubtful prey	Concave lid	Removal of lid	Convex lid	Daub	Smooth	Last inspections	Last Departure	End of Watch	Totals	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
15/7	—	—	*?*	x on I	x on I	—	—	—	—	—	—	—	—	—	—	—	—	—
	09.24	—	—	—	25(+2) on I	—	—	—	—	—	—	—	—	—	10.06.59	11.44	—	—
	—	—	*?*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	11.47	11.48.45	—	—	—	1 in I	—	3 in I+*3*	2 on I	—	—	—	—	—	13.46.30	14.47	—	—
	—	—	—	—	—	—	—	—	—	—	—	—	—	*?*	—	—	31(+2)	*3*+ x
16/7	—	—	*?*	—	—	—	—	—	—	x from I	—	—	—	—	—	—	—	—
	—	—	?	—	—	—	? in I	—	—	—	—	—	—	—	—	—	—	—
	07.30	08.09.24	—	—	—	—	—	5 in I	—	—	—	—	-	—	-	—	—	—
	—	—	—	—	—	—	1 in I	—	—	—	5 on I	—	—	—	—	—	—	—
	—	—	—	9 on II+*3*	22 on II	2 in II	—	—	—	—	—	—	—	—	11.45.37	11.47	—	—
	—	—	—	—	—	—	? in II + *?*	—	x on II+*?*	—	—	x	—	—	—	—	—	—
	14.00	14.44.50	—	—	—	—	—	—	—	—	—	—	—	*1*	14.46.05	18.07	44	*4*+ x
17/7	06.14	09.13.22	*0*	—	—	—	—	—	—	1 from II	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	3 in II +*3*	1 in II+*2*	2 on II+*1*	—	—	—	—	*0*	14.29.20	18.15	7	*6*
18/7	06 52	09.07.03	*0*	—	—	—	—	—	—	1 from II	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	3 in II + *8*	—	—	—	7 on II+*2*	29	1	—	—	—	—	—
	—	—	—	13 on III	24 on III	—	—	—	—	—	—	—	—	*0*	16.51.38	18.21	78	*10*
19/7	07.15	08.48.50	*2*	—	—	1 in III	4 in III + *2*	1 in III	—	—	6 on III	—	1	—	—	—	—	—
	—	—	—	5 on IV	27 on IV	—	—	—	—	—	—	—	—	*1*	17.20.59	18.46	45	*5*
20/7	07.12	07.54.25	*2*	—	1 on IV	1 in IV	2 in IV +*2*	2 in IV	—	—	8(+1) on IV+*2* (+*1*)	12	2	—	—	—	—	—
	—	—	—	1 on V	—	—	—	—	—	—	—	—	—	*0*	14.47.11	18.23	29(+1)	*6*(+*1*)
21/7	06.43	07.07.06	*1*	—	—	—	—	—	—	—	1 on IV	32(+1)	13	—	—	—	—	—
	—	—	—	19 on V+*1*	29 on V	1 in V	8 in V+ *2*	2 in V	—	—	12 on V	—	—	—	16.23.45	18.46	117(+1)	*4*
22/7	06.13	07.04.03	*1*	5 on VI	25 on VI	1 in VI	5 in VI + *2*	—	—	—	10 on VI	5	1	—	—	—	—	—
	—	—	—	11 on VII+*1*	26 on VII	2 in VII	1 in VII	—	1 on VII	—	—	80+*3*	34	*0*	17.14.30	18.32	207	*7*
23/7	06.11	08.07.13	*0*	—	—	—	—	—	—	1 from VII	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	3 in VII+*2*	3 in VII	—	—	4 on VII+*1*	—	—	*0*	10.40.46	18.45	11	*3*
24/7	06.30	07.41.35	*1*	—	—	—	—	—	—	—	3 on VII	1	—	—	—	—	—	—
	—	—	—	1 on VIII	30 on VIII	1 in VIII	11 in VIII+*3*	1 in VIII	—	—	6 on VIII	1	—	—	—	—	—	—
	—	—	—	2 on IX+*1*	25 on IX	—	—	—	—	—	—	—	—	*0*	15.53.28	18.32	82	*5*
25/7	06.23	07.29.25	*1*	—	—	1 in IX	1 in IX+*4*	—	2 on IX+*1*	—	—	—	—	—	—	—	—	—
	—	—	—	4 on X	—	—	—	—	—	—	—	57+*4*	4	*2*	17.29.31	18.43	69	*12*
26/7	06.23	07.08.17	*1*	—	—	—	—	—	—	1 from IX	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	7 in IX +*4*	1 in IX+*1*	—	—	9 on IX	6	—	—	—	—	—	—
	—	—	—	10 on X+*1*	29 on X+*2*	—	—	—	—	—	—	—	—	*1*	17.01.08	18.32	63	*10*
27/7	06.10	07.31.30	*1*	—	—	1 in X	4 in X + *7*	—	2 on X+*1*	—	—	53+*1*	13	—	15.46.32	18.30	73	*10*
28/7	06.39	?	*?*	—	—	—	—	—	—	(+1)+1 from X	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	2 in X + *5*	—	—	—	—	—	—	—	11.39.31	18.34	3(+1)	*5*
	—	—	*10*	80 *7*	263(+2) *2*	12	51 spiders *44* +3 flies +1 spider escaped	19 *6*	9 *3*	4 (+1)+ x	71(+1) *5*(+*1*)	276(+1) *8*	69	*5*	—	—	—	*90*(+*1*)

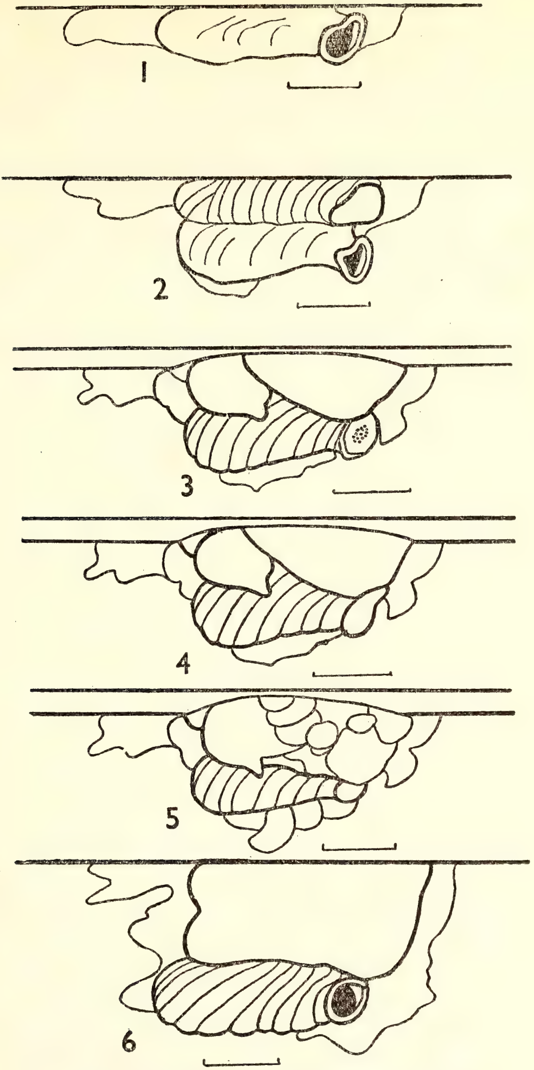
NOTE. Numbers in brackets visits counted but not timed. Numbers in italics inspections immediately before and during relevant activity, except for first and last inspections of day which are listed separately.

the cell with most of her body inserted. She left at 09.24.39. This long period on the nest, involving both intensive inspection and pauses, is characteristic of those visits which involve the removal of a concave lid. On only one occasion (26/7) were they not the first of the day. During the next 5 hours the wasp made 9 visits, on 3 of which she brought a spider, on 5 of which she brought nothing, but inspected both the inside and the outside of the cell, and on 1 of which it is uncertain if she brought anything (Table I).

The visits on which prey was brought to the cell were interspersed with inspection visits, and both kinds of visits were preceded by absences of irregular length sometimes of more than an hour. On 9 occasions during the 14 days of observation the wasp had inserted her head into the cell before the observer could be sure whether she was, or was not, carrying an animal. After our experiences on the first two days we are sure that loads must sometimes have been missed. We did not notice a stereotyped landing pattern, as Shafer (1949) did in specimens of *S. caementarium*; our wasp landed either on the table, or on any part of the construct. However she did have a stereotyped departure, always running to approximately the same place on the wood before taking off. At 14.23 she closed the cell with another concave lid. Rain did not start until 16.12, and was intermittent.

18/7. The second concave lid of cell II was again removed at the first visit. During the next 5 hours she made 1 inspection, brought 1 spider, made 7 inspections, brought 2 spiders, and with 3 loads of mud made the knob or convex lid shown in Fig. 4. After 2 more inspections she *daubed* the lid. She then put a similar daub elsewhere and one more on the lid. She then entered a period of *daubing.* This activity was more rapid than wall building. The ball of mud was put with some violence (' slapped down '), at first on the cells, and later on the previously deposited roughcast. She sometimes carried her ball for some seconds, sweeping actively over a large area before depositing it. She sometimes swept after deposition ; but among daubing visits alone were a few where no sweeping *at all* was performed. She worked fairly systematically from above downwards, covering the structure built on the 16th. Once she left this structure and redaubed lid 11. The roughcast completely covered the cells, hiding their individuality and uniting them into a single block. The wasp's mechanics were sympathetic, in the sense that the observer could usually appreciate a reason for a daub being put where it was ; the observer had been able to see an irregularity of edge or of surface which the daub obliterated.

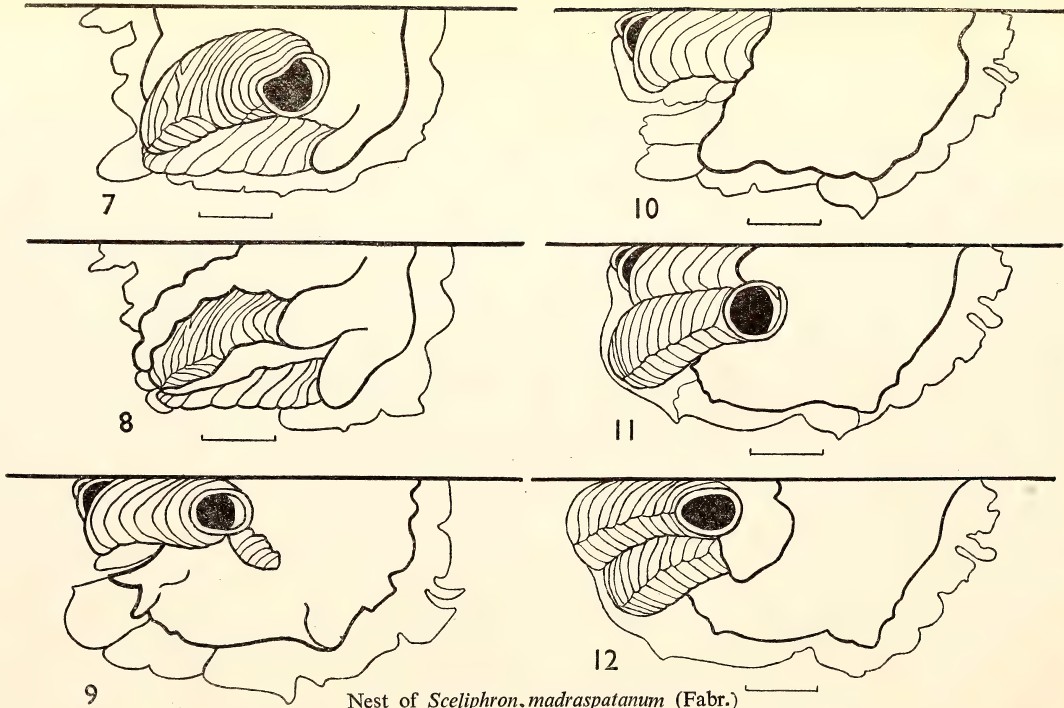
During such a daubing period some balls of mud were spread as a thin film on the table. During the period discussed on 18/7 all but



Nest of *Sceliphron madraspatanum* (Fabr.)

1. 15-7-60, 10.06.59. Cell I newly built and open. **2.** 16-7-60. 10.57.46. Cell I sealed by permanent convex lid. Cell II newly built and open. **3.** 16-7-60. 14.00. *seen from below*. Cell II sealed by 1st temporary concave lid. Cell I daubed with roughcast. **4.** 18-7-60. 13.58.35. *seen from below*. Cell II sealed by permanent convex lid. **5.** 18-7-60. 14.48.51. *seen from below*. Roughcast extended to partly cover cell II and convex lid. **6.** 18-7-60. 16.51.38. Cells I and II completely covered by roughcast. Area of smeared mud extended. Cell III newly built and open.

(The small horizontal line below each figure represents 1 cm.)



Nest of *Sceliphron madraspatanum* (Fabr.)

7. 19-7-60. 16.03.38. Cell III closed by permanent convex lid. Cell IV newly built and open. **8**. 20-7-60. 14.47.11. Cell IV sealed by permanent convex lid. Two new longitudinal bands of roughcast. **9**. 21-7-60. 10.07.23. Cell IV almost completely covered by roughcast. Area of smeared mud extended. Cell V newly built and open. Note false starts of cell V which is insufficiently foreshortened. **10**. 21-7-60. 16.23.45. Cell V permanently sealed and area of roughcast extended over convex lid. **11**. 22-7-60. 8.11.47. Cell VI newly built and open, and again insufficiently foreshortened. **12**. 22-7-60. 12.59.47. Cell VI permanently sealed and convex lid daubed over. Cell VII newly built and open and again insufficiently foreshortened.

one were spread where the next cell, cell III, was immediately built upon them. They are therefore classified as *foundations*. One load however was placed elsewhere. Such an action is called a *smoothing*. A foundation and a smoothing are physically the same complex spreading movement, and were first distinguished by their final function in the nest. The distinction was confirmed by two observations; firstly the duration of a period of foundation building was about a quarter as long again as a period of smoothing though both periods showed a very similar amount of variation (Table IV). Secondly, the wasp was away significantly longer when fetching mud for a foundation than for a smoothing (Table V). At the close of a period of daubing and smoothing activity the observer could usually recognise where the next cell would be constructed by a concentration of spreading movements in one region. Usually after an absence (on 18/7 it was of 1863 seconds) the foundation loads became predominating and the walls were begun. The wasp completed cell III without pause and left for the night (Fig. 6). Our wasp therefore did not behave like those described by Fabre (1924) and Dutt (1913). The latter state, that all *Sceliphron* species including *madraspatanum* complete *all* the cells in a nest, then roughcast them all together, and desert the construct immediately[1]. Our wasp, all told, had 7 periods of intensive daubing, and a few occasional loads were daubed on between these.

Dutt (1913) also considers that the smeared mud surrounding the block is the result of the wasp dragging her mud balls over the surface. We agree with Horne (1872) that these smears are deliberately made. The smoothing-foundation activity was very characteristic, and took more time than daubing (Table IV). We are sceptical of Horne's

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[1] In 1961 another nest was found in the same room. Unfortunately this was found after emergence of the imagines, so that we cannot be dogmatic that it belonged to *S. madraspatanum*. However in cell structure it resembled the nest that we have described, but unlike ours it confirmed Dutt's statement about the timing of what we call block daubing. This nest contained 21 cells, one vertical row of 8 being laid flat on the wood and two others of 7 and 6 respectively being built on top of them, so that the long axes of all cells were parallel. The cell which must have been the last built, whatever the hypothesis of the order of construction, was completely empty, and had never received a permanent lid. As it thus resembled our cell X (p. 13) this nest also seems to have been deserted unfinished. All the other cells had been permanently sealed, and the lid daubing was conspicuous covering the rims of the ridged cell walls for, as Dutt would have expected, no other part of the construct had been covered or embedded. This nest therefore also confirmed our association of the lid daubing with cell construction (p. 23) not with the block daubing which in our nest often followed it immediately. Dissection of the nest confirmed that the cells had been built directly on each other, the outer wall of one forming the floor of those above it, without, as in our nest, any daubing between. Fifteen cells had emergence holes in their lids and contained broken cocoons and two kinds of faeces exactly like those described on (p. 16). The remainder whose permanent lids were unperforated were filled with dried spiders and strongly suggested that no egg had been hatched, or perhaps laid, in them.

suggestion that the smeared mud has a cryptic function by resembling splash, and our animal, unlike his, made no isolated 'drop' marks. The mud was carried daintily in the mandibles high above the surface of the substrate, and the wasp often swept for some time before she deposited it. Indeed the mud was of such a consistency that most of any load would stick where it first touched.

19/7. The wasp first made 2 inspections separated by 7018 seconds, departed for 4450 seconds, returned with a spider, made a single ovipositional entrance, then made an imperfectly seen visit, and 2 inspections. She then brought a *fly* of a small grey waxy sarcophagine-like species. The fly was carried parallel to the wasp's long axis under her body. Its russet eyes were visible under her head, and so were the segmented abdomen and the wings crushed together under the much more slender abdomen of the wasp. That flies are prey for members of this genus confirms the observation of Rukov which Kohl (1918) quotes with derision. She then brought 3 undoubted spiders and immediately sealed the nest with a convex lid built of 4 loads of mud, and obliterated it with 2 daubs. After 1 load smoothed on the wood, she spread 4 loads consecutively: these proved to be foundation of cell IV, or more correctly the foundation of the *end* of cell IV, because cell IV was the first to be built mainly overlapping the previous construct. She made 4 visits building the walls of cell IV, but on her next visit she pushed her load of mud behind outside the upper rim. She finished the cell with 23 more loads, left for 4627 seconds, made a short inspection (14 seconds) and left for the night (Fig. 7).

20/7. She began the day with 2 inspections separated by 6247 seconds. She then brought one load of mud and added it to the upper wall of cell IV. After 2848 seconds she brought a spider, oviposited, and then spent 10 minutes inspecting the outside. She then made a visit in which the load was uncertain, then 2 inspections, and then 2 more visits on which she again brought *flies*. Then, after a doubtful visit, she made 3 inspections and closed the nest with 3 loads of mud, making a convex lid. She then joined this lid to the block, partly obliterated it with 3 more loads, and began roughcasting in two bands, one above and one below the newly sealed cell IV. While doing this, she added 3 daubs specifically to the convex lid of IV, and smeared 3 loads on the table, one of which became part of the foundation of cell V. Her last departure was after the light had begun to fail and heavy rain was, correctly, anticipated (Fig. 8).

21/7. She opened the day with one inspection, put a load of mud on lid IV, and then made 31 visits daubing mud, covering cell III completely, and almost covering cell IV. Among these she made 5 visits spreading mud on what proved to be the foundation of cell V, and 11

smoothing mud elsewhere on wood, including that to the north or window side of the construct in front of the sealed mouths of II and III. After being absent for 1566 seconds she inspected and then made 14 foundation building visits among which were 2 daubing and 2 smoothing visits. She then constructed the walls of cell V, between cell IV and the table top. For details here, and in the rest of the description of construction, see Table I. The first few arches of the upper wall remained outside the final cell (Fig. 9). She oviposited, provisioned with spiders, and sealed with a convex lid which was immediately joined by daubing to the part of the block already constructed (Fig. 10).

22/7. This day was the peak of her productivity. She made 214 visits and worked for 10 hours 10 minutes. She began with an inspection, and built cell VI immediately (Fig. 11). During this she made two daubs, probably necessary architecturally for the cell construction. At the beginning of this building we moved the left, or south, corner of the table away from the wall so that the wall and the back edge of the table made an angle of about 14°, i.e. the nest had been turned slightly towards the window. This removed the south side of the nest, where building was being done, from the shadow cast by the completed part. On the next visit, the wasp approached about 10-12 cm. to the left of the nest, but immediately doubled back to land on it. The wasp oviposited in cell VI only just over an hour after her first arrival in the morning, put in 5 spiders, sealed it permanently with a convex lid made from 4 loads, and began the foundations of cell VII before she finished daubing the lid. She built cell VII, again including a few daubs on the block (Fig. 12), left for almost an hour, and brought a spider. She made an ovipositional entry, then removed the spider and tried again. She then threw the spider out, swept, and left to return with another after 1065 seconds, and repeat the complete entry abdomen first. She added one more spider and sealed the cell with a concave lid made from a single load. It was then 14.45. She then brought 114 loads of mud, 80 of which she daubed, and 34 of which she smoothed, some of them on the vertical edge of the table top itself. The appearance of the block and the area of smoothed mud surrounding it was entirely altered (Fig. 13). On this occasion alone she roughcasted a cell which was incompletely provisioned. She left a distinct groove from the edge of the table top to the rim of lid VII which she used next morning to insert her mouth-parts to bite the lid off. During this period of intense construction she made three visits purely to inspect.

23/7. The day started with heavy rain. The animal arrived 5 minutes after sunshine was first noted, and after sweeping, removed the concave lid of cell VII. The cell was provisioned. The abdomen of

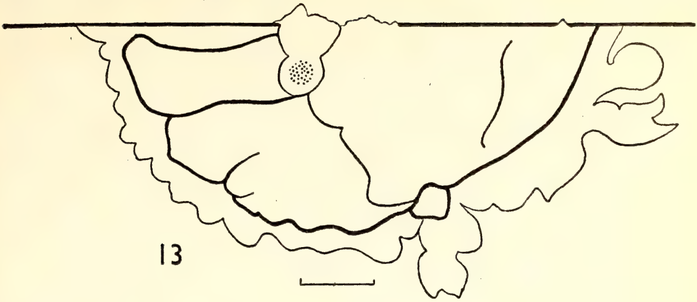
the last spider brought was too large to enter the hole and a 2-minute long struggle was seen. First the spider was pushed in head first as usual. Then it was deliberately turned round and an attempt made to push in the abdomen. The spider dodged the hole actively, and walked away carrying the clinging wasp. The wasp finally dropped the spider and spent nearly 3 minutes wiping her body and sweeping the block. The spider was motionless when retrieved from the floor by the observer. One inspection visit was then made, and then surprisingly, the cell was sealed permanently. This convex lid was left undaubed, probably because it rained for the rest of the day.

24/7. After the usual initial inspection visit, the animal brought mud and completed the lid on VII by daubing on it. After one more daub on VII the wasp built cell VIII (Fig. 14), oviposited, provisioned, permanently sealed it ; and promptly built cell IX leaving it empty and open for the evening (Fig. 15). Only 1 load was spread on wood as a foundation for VIII and only 2 for IX. These two cells were built almost entirely over the previous ones. Cell VIII also showed some imperfections in its walls.

25/7. After the first inspection, she laid in cell IX and another spider was introduced. There were many inspections. The cell was then sealed temporarily with a concave lid. Within 2 minutes of completing this, heavy rain and thunder began. The wasp returned over an hour later, within 10 minutes of the rain ceasing, and daubed mud covering cell VIII and part of cell IX (Fig. 16). After more rain, she made her last visit, a curious inspection lasting 917 seconds. It contained two pauses during which she was motionless for 3 minutes. She repeatedly returned and swept the lid of cell IX, as though she had a guilty conscience about leaving it.

26/7. Today the wasp did not remove the concave lid at her first visit but at her second, which was 1766 seconds later and involved much inspection. After gnawing round the lid she seemed to kick it off because it did not fall vertically. Cell IX was further provisioned, and sealed permanently with a convex lid, roughcasted over as usual. Foundations of cell X were begun, alternating with this lid daubing, but 6 generalised daubs were also made before the cell walls were begun. These could not be interpreted as preparing the block surface for cell X. Cell X was built immediately (Fig. 17). The day ended with an inspection, 2 hours and 40 minutes after the last load of mud had been brought. The weather was sunny during this intervening period.

27/7. After the morning inspection visit, oviposition took place in cell X. She then re-entered the cell head first, then again abdomen first carrying a small flake of mud with her. Four more spiders were



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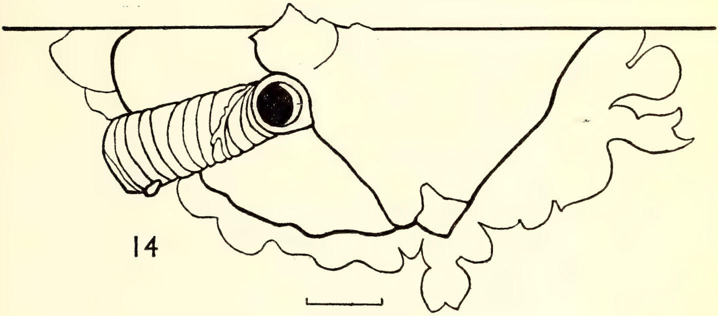

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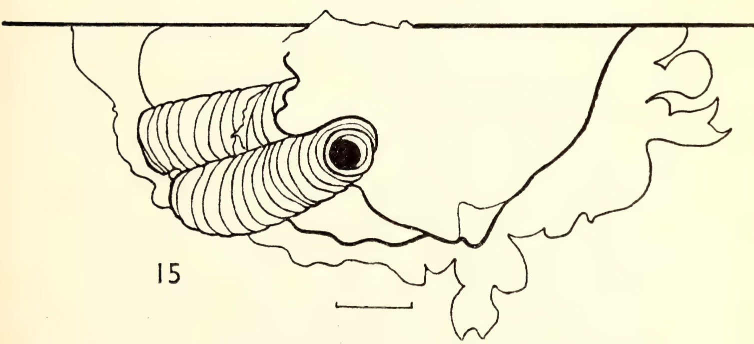
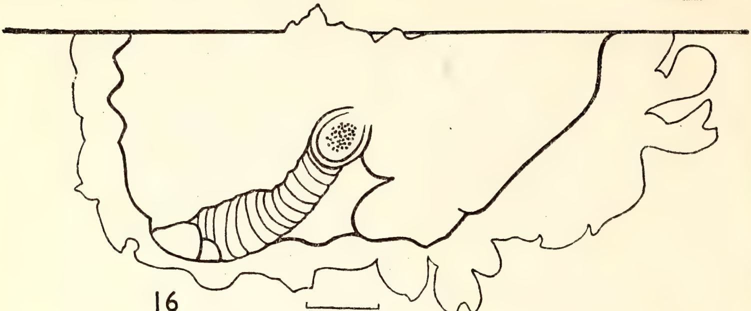


15

Nest of *Sceliphron madraspatanum* (Fabr.)

13. 22-7-60. 17.13.32. Cell VII sealed by temporary concave lid to which ridge runs through roughcast to facilitate it being bitten out next morning. Cells VI and VII covered by roughcast and smeared area much enlarged especially to observer's right. **14**. 24-7-60. 9.15.10. Cell VII sealed by permanent convex lid which has been daubed over with roughcast. Cell VIII newly built, open, insufficiently foreshortened. Note imperfection of walls. **15**. 24-7-60. 15.53.28. Cell VIII sealed by permanent convex lid which has been daubed with roughcast. Cell IX newly built and open.

(The small horizontal line below each figure represents 1 cm.)



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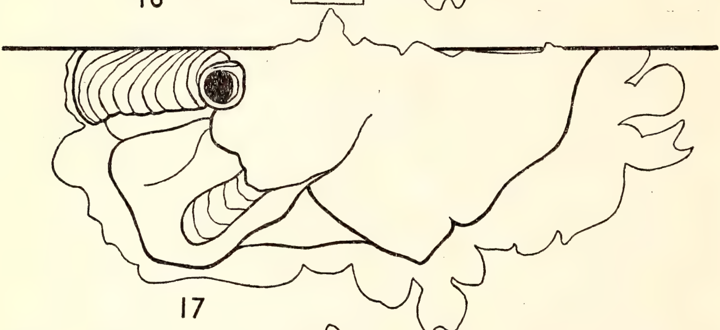

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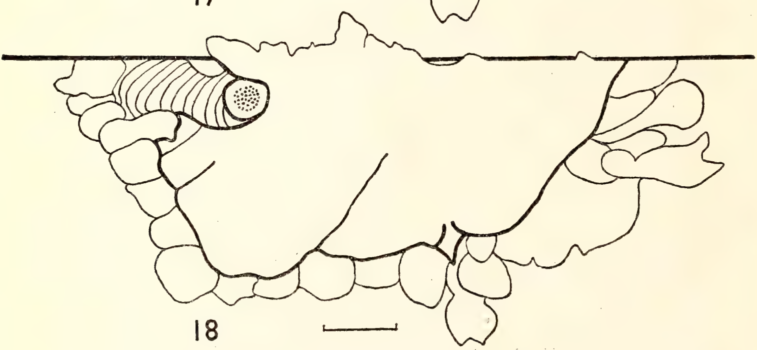

18

Nest of *Sceliphron madraspatanum* (Fabr.)

16. 25-7-60. 17.29.21. Cell IX sealed by temporary concave lid. Cell VIII completely covered by roughcast. **17.** 26-7-60. 15.18.47. Cell IX partly covered by roughcast. Cell X newly built and open. **18.** 27-7-60. 15.46.32. Cell X sealed by temporary concave lid. Cell IX completely covered by roughcast.

(The small horizontal line below each figure represents 1 cm.)

introduced, the cell was closed by a temporary concave lid and the wasp immediately daubed cell IX completely, interspersed with the smoothing of mud to the south of the block.

28/7. At 06.39 the observer found the wasp already on the construct. This morning she spent most of the time waving her antennae in the air rather than sweeping. She spent several isolated periods absolutely still, one of about 5 minutes. After being watched for 10 minutes she bit the lid. She was then deliberately disturbed by being blown upon, and, after hovering over the construct, left. She had thus been on the construct over 625 seconds before beginning lid removal, most of which time she was motionless. On the 4 previous occasions on which lid removal was seen, she had not only been extremely active but on 2 had begun biting in under 1 minute from arrival, in 1 in under 2, and in the fourth, from cell VII, had begun biting in about 4 minutes. Therefore, before she was disturbed she was behaving abnormally, by being lethargic. This doubly incompletely recorded visit is not considered in Table IV.

She returned after 2399 seconds, examined the cell for 916 seconds during which she was again motionless for periods of 2, 6, and 2 minutes. She took just under 290 seconds to remove the lid, during which time she walked away from it once and left after 50 seconds of inspection. This complete visit, which almost certainly would not have occurred if the animal had not been disturbed on her previous visit, is considered in Table IV.

After 1 inspection she brought a spider, and was then interrupted by rain, followed by 1 inspection and 1 spider after more rain. She made 3 more inspections, the last after an interval of 4300 seconds during which there was no rain. Rain was recorded during the afternoon, but there were also long sunny periods. Watching was discontinued at 18.35.

29/7. The nest was watched from 06.13 to 13.38. There was again rain, but neither in duration nor in intensity sufficient to stop her, judged by previous days. No further addition was seen to the construct.

There are two interpretations. Either the wasp deserted the nest, perhaps because the gust of air produced by a human blowing gently had an unexpectedly great valence for her, and a valence quite different from that of the occasional unintended disturbances caused by sudden movements of the observers. If this is so, two aspects of her behaviour are unexpected; she neither deserted immediately, nor, alternatively, brought the provisioning for her last offspring to a satisfactory conclusion. Alternatively, we may interpret her languor, seen before the disturbance, as a sign of senility, or malaise, so that she did not desert, but died, perhaps being too slow to escape a predator. If

she was becoming senile, it is curious that she arrived at least 30 minutes earlier than on any previous day. Perhaps we have missed visits in the early mornings, even after 16/7, but these could only have been visits of inspection.

The data collected on the 14 days are summarised in Table I. The building activities are set out in the functional order of the building, provisioning, and sealing a cell, though only on 15/7, when it was not observed, and on 22/7, was the first activity foundation building. Inspection visits except for the first and last of the day have been associated with the chore which they *preceded.*

Most activities are performed in bursts, and the order of these bursts is shown in Table I. However, the irregular alternation of 'certain' prey and 'doubtful' prey has not been shown, nor the irregularity of lid daubing, block daubing, smoothing, and foundation spreading. This can be generalised by saying that the wasp gradually transfers her attention from the lid she has just sealed to the construct as a whole, and then her attention gradually narrows to the place where her next cell will be built. Dutt (1913) records that he scraped off the two cells which he found in a particular nest. As the wasp daubed over the surface he had broken and, as Dutt considered that daubing is only done before the nest is finally left, he suspected that the daubing follows 'a set routine'. We disagree; and once a cell is sealed we consider that the consummatory stimuli (as the ethological school following Sherrington would call them) sought during daubing are provided by the suitability of the construct as a whole to receive another cell, *not* by the disappearance of the cell being covered.

31/7. 19.00 approximately. The contents of cell X were noticed very near the cell mouth, and at about 20.00 the larva of X was found on the floor. It was quite motionless, and it was preserved.

1/8. 10.30. The entire table was removed to an insect cage out of doors which was covered by a tarpaulin. At 14.15 the temperature under the tarpaulin was 47° C. Therefore the table was sawn up and the nest, still attached to the wood, was stored resting on blotting paper, in a large glass jar covered with muslin.

Seven wasps emerged, all perfect. They were killed a few hours after emergence. Details are given in Table II. The diameter of the emergence holes was about 4 mm., i.e. much less than the diameter of a newly finished cell mouth. The lids removed were in the same place as the lids constructed by the mother, and were surprisingly thin flakes, considering the thickness of the mud layer with which the cells had been sealed and individually roughcasted. The lids were cut almost, but not quite, all round their circumferences and were left on cells VII, VIII, and IX, those from VII and IX being left parallel to the

surface of the block and in a position that still partially closed the exit to the cell. When the nest was dissected on 3/5/61 it was discovered

TABLE II

PARTICULARS OF EGG-LAYING AND EMERGENCE

Cell	Laid	Emerged	Length of pre-imaginal life in days	Sex	
I	15-7, a.m.			♂	see text
II	16-7, ,,	5-8, a.m.	20	♂	
III	19-7, ,,	8-8, ,,	20	♂	
IV	20-7, ,,	9-8, ,,	20	♂	
V	21-7, ,,			♀	see text
VI	22-7, ,,	12-8, ,,	21	♀	
VII	22-7, p.m.	11-8, ,,	19·75	♀	
VIII	24-7, a.m.	13-8, noon	20	♀	
IX	25-7, ,,	14-8, p.m.	20·25	♀	
X	27-7, ,,			?	see text

that the cocoon in cell I was in a reversed position, the faecal cup being proximal to the lid ; that a tunnel 4-5 mm. long had been bored from distal end of cell I, into the wall of cell V which contained a crushed female pupa, presumbly V, facing its component lid, and a male wasp, with expanded wings, presumably I, facing away from lid V. Both were dead.

The length of pre-imaginal life was remarkably constant and the same for both sexes though perhaps more variable in females. It was about 3 days less than the minimum Dutt (1913) observed in specimens of this species at Pusa in Bihar. That all the males emerged before all the females is an example of the proterandry that Kohl (1918) expected would be found among *Sceliphron* species. However, at least for this sibship, the explanation is *not* that the males develop more rapidly than the females but that *all* the male eggs (4) were laid before all the female eggs (5) (*protarrhenotoky*, Jayakar 1963) an observation expected to be made by chance once in 126 times. If males are haploid, as they are in all Hymenoptera studied (White 1954 p. 326), the fertilization of the wasp observed *may* have occurred after the

construct was half built, and this fertilization may have stimulated the great burst of activity on the 21/7 and 22/7. Alternatively some maturation of the female's spermatheca, or of the sperm within it, may be necessary in this species before fertilization can take place. There are other possible explanations. The dissection of the nest revealed the cocoons. In this species, these resemble those described by Fabre (1924), being of a thin russet lac-like substance suspended by white silk threads from the mud wall, which was itself thinly lined with silk. We disagree with Dutt (1913) that the cocoon is spun. Spun threads were rare in samples we have examined. The cocoons were rounded and broader at the end which covered the head and thorax of the pupae, and which except in cell I lay proximal to the lid. At the distal end the cocoon narrowed to a hard black cylindrically walled cup about 2 mm. in diameter, and about 3 mm. deep. These cups contained an earthy substance which was debris of arthropod cuticles. This confirms Dutt (1913) who claimed it to be larval faeces. However, among this debris in the two cups examined, a small fibrous moulded lump was found of a different shape in each case. This seems to be the unused lac which Morley (quoted by Kohl 1918) states is excreted into these cups. On the surface of this debris we always found a larval moult. Only in one cell did we find any structure which might have been a pupal moult. This, therefore, seems usually to be eaten, or must be very inconspicuous. Finally, in all cells but I, II, and V, we found a layer of fusiform white pellets. Further pellets were found loose in the cell, and they were also found on the floor of the glass jar. Shafer (1949) observed that in *S. caementarium* such pellets were present in the larval tissues, gradually increasing in number during development, so they can only in part be a meconium due to the metabolism of metamorphosis, though they are not passed until after the emergence of the imagines. The cocoon was messily broken, and sometimes in fragments at the head end. In cell **V** the head end was complete, and the rupture was distal and seemed not to have been made by the occupant, but by wasp I who was an intruder in cell V.

III. Analysis

Table III presents a summary of those loads assumed useful to the developing larvae ; i.e. inspections, removals, and unsuccessful introductions of prey have been omitted.

The separation of *foundation* from *smoothing* first made on function is justified by the observation that the animal spends more time on the former (Table IV). That the two means have very similar variances suggests that they have been accurately separated during recording.

TABLE III

LOADS ACTUALLY USED ON THE NEST

Larva	Foundation	Walls	Spiders and flies inserted, incl. oviposition	Doubtful prey	Sum of possible prey	Concave lid	Convex lid	Daubs on convex lid	Daubs	Smooths	Sum of daubs and smooths (2 odd loads omitted)
I	x	25+ ?	2	8	10	2	3	2	x	x	..
II	9	22	6+?	1	7	x					
						2	3	4	29	1	30
III	13	24	5	1	6	..	4	2	..	1	..
IV	5	28	3	2	5	..	3	7	45	15	60
V	20	29	9	2	11	..	5	7	..	..	..
VI	5	25	6	..	6	..	4	6	85	35	120
VII	11	26	4	3	7	1	4	3	1	..	..
VIII	1	31	12	1	13	..	3	3	58	4	62
IX	2	24	9	1	10	2	3	6	59	13	72
X	14	29	7	0	7	2	..	..	..	..	..
Mean	8·9	26·3	6·3	..	8·2	..	3·6	4·4	..	..	68·8
σ^2	33·9	8·0	9·3	..	6·8	..	0·5	4·25	..	..	1065·2
C.O.V. %	65	11	49	..	32	..	19·6	47	..	..	47

Identifying and classifying journeys associated with walls, oviposition and prey, and the two lids presents no difficulty. Daubing is a characteristic activity, but it is not associated with one cell at a time. A few daubs seem to have been put on separately to improve the surface for a cell under construction, or at least, in contemplation. In Table III daubing and smoothing visits are classified with the cell which had last been *permanently* sealed with a convex lid. On 4 occasions the next cell (II, VII, IX, X) also had been temporarily sealed after partial provisioning. Only cell VII on 22/7 was covered with daubs to any great extent before being permanently sealed. Some figures in Table III are as might have been expected from the function of the chore to which they refer. It seems reasonable that the number of loads used to construct a foundation should be variable while those used to construct the cell walls should be constant, because the function of a foundation is to respond to exigencies, whereas the function of a cell is the *raison d'être* of the whole structure, and this does not differ from cell to cell. Similar considerations would lead us to expect the observed standardisation of the number of loads used to make the two kinds of lid, and the variability of the number used in both lid and cell daubing and smoothing.

Fabre (1924) counted 15-20 ridges on the cells of the European species diagnosed now as *spirifex*. He considered that each ridge represented one load. In *madraspatanum* at least, a ridge represents two loads. If this is so also for *spirifex* the cells of the two species require a similar amount of work to build, though those of *spirifex* are about 0.5 cm. longer. The numbers of prey are smaller than those given by previous authors, 11-24 by Shafer (1949) for *S. caementarium*, and 'about 18' by Dutt (1913) for the present species. What is surprising is the great variation in the numbers introduced. Table III shows that this variation can be very little an artifact of our doubts as to how many there actually were. This variation surprised us while observing; we were never able to predict when the wasp would be satisfied and seal the cell. Many species of spiders are used, and one large must be equivalent to many small, but this was not obvious during watching, and cannot always be appreciated by the wasp. For example the spider that escaped from cell VII on 23/7 was the last brought and, after one inspection, the cell was sealed. There was no compensation for this, the largest spider seen, which she had at one time intended to introduce.

The duration of the periods spent on the cell is an indication of the difficulty of, or care taken with, the work. These periods consist of two components, not consistently separated in the record. Firstly the time taken 'handling' material, and secondly the time taken deciding where to put the load, and/or examining it in position. This

TABLE IV

DURATION OF TIME IN SECONDS ON CELL

Operation	Visits seen	Visits timed	Smallest	Largest	Mean	IQR/Median %	c.o.v. %	Median	s.e. of Median: Estimate 1	s.e. of Median: Estimate 2
Daubing block ..	277	276	9	129	27·18 ± 0·90	47	55·1	23·70	0·46	0·66
Daubing lid ..	40	40	9	125	33·73 ± 4·34	85	81.3	23·50	1·84	2·95
Smoothing ..	69	69	12	91	35·55 ± 1·66	52	38·8	33·25	1·56	1·93
Walls ..	265	263	20	246	44·56 ± 1·13	34	41·0	41·60	1·01	0·85
Foundation ..	80	80	18	98	46·76 ± 1·94	49	37·2	45·17	3·72	2·30
Convex lid ..	32	31	26	169	53·94 ± 6·65	92	68·7	38	6·65	4·73
Concave lid ..	9	9	46	244	126·56 ± 24·08	104	57·0	126	24·08	40·26
Lids combined ..	41	40	26	244	70·23 ± 8·76	137	78·8	45·375	3·16	9·24
Doubtful prey ..	19	19	10	82	35·05 ± 4·38	74	57·9	31·0	—	—
Certain prey ..	55	55	11	315	55·25 ± 7·74	64	104·4	40·25	—	—
Oviposition ..	12	12	47	720	172·50 ± 52·0	53	104·5	106·5	—	—
Inspection ..	91	90	8	917	87·13 ± 14·00	156	152·6	42	—	—
Lid removal ..	6	5	335	1307	695·60 ± 163·59	—	52·6	625	—	—

examination often seems to include deciding where to place the next load. The latter component seems more variable than the former, and the extremely long visits that sometimes make the median a more useful statistic than the mean, owe their length almost entirely to the sensory or inspecting component. The times spent *away* from the cell before a given activity can be similarly analysed. If the activity on the cell involved bringing a load, some of the time away must have involved finding it and, when an animal had been only 8 seconds away when she returned with a ball of mud, we may assume that she spent most of the time collecting the mud. However, the existence of extremely long absences suggests that the wasp sometimes performed other activities besides collecting while she was away.

Our wasp's quantitative behaviour while on the nest was probably typical of the species in this climate, as we assume her qualitative behaviour to have been, but the times during which she was away must have been very closely determined by the nearness of suitable mud, and perhaps, but less certainly, the ecology of the local spiders, i.e. these periods will differ from locality to locality, and season to season, and must not be assumed to be characteristic of the species.

Tables IV and V summarise the data on periods, on and away from the cell respectively. In Table IV the mud carrying activities have been ranked in order of mean length of durations, beginning with the shortest, i.e. *block daubing*. The order judged by the median is similar, and for the *lid building*, where there were a few extremely long visits, more informative. For the other visits, *bringing prey*, and *inspecting*, the mean and median are surprisingly near together considering the small totals, and the variation.

The durations of absences were so skew that the mean is meaningless. Therefore ranking in Table V has been performed on the medians.

Considering the work with mud, these rankings suggest generalizations. However, comparisons require some measure of the reliability of the statistics. There is no satisfactory formula to estimate the standard error of a median, and the differences between the values obtained by the use of various *ad hoc* formulae reveal that the assumptions on which they are based are not true of the populations concerned.

Estimate (1) was calculated from the formula $\frac{1}{2\sqrt{n}} \cdot \frac{1}{f_c}$, where f_c is the median ordinate and is estimated from the central 5 or 6 values in the sample, depending on whether n the total sample size was odd or even. We are thus assuming regularity of the sample just around the median. The abnormally high standard error of *foundation making* is due to an irregularity in this region, which, knowing our

TABLE V

TIME IN SECONDS AWAY FROM CONSTRUCT IMMEDIATELY BEFORE AN ACTIVITY

	No. timed	Smallest	Largest	Mean	Q–	Q+	$\frac{\text{IQR}}{\text{Median}}$%	Median	s.e. of Median	
									Estimate 1	Estimate 2
Smoothing ..	69	8	109	37·6 ± 2·3	27	42	48	31·0	1·00	1·68
Block daubing ..	275	14	559	41·1 ± 2·3	29	43	42	33·0	0·95	0·78
Foundation ..	80	17	1863	106·5 ± 29·3	33	61	71	39·5	2·32	2·91
Walls ..	263	21	504	50·7 ± 2·9	34	52	45	40·23	0·91	1·03
Lid daubing ..	40	29	832	93·1 ± 12·6	35	60	62·5	46·0	2·50	3·69
Convex lid ..	30	28	354	93·1 ± 22·4	46	107	88	69·5	9·02	10·30
Concave lid ..	9	43	479	142·3 ± 44·9	67	147	80	100·0	28	24·77
Lids combined ..	39	28	479	102·7 ± 14·3	51	109	78	74·0	9·37	8·69
Doubtful prey ..	18	120	3863	1044·1	434	1580	144	797·5	99·5	
Certain prey ..	55	165	3576	1122·9	511	1400	88	1015·0	113·5	
Oviposition ..	12	262	6106	2413·0	1133	3182	92	2218	441	
Inspection ..	82	40	7018	1878·5	809	2127	79	1658	122	
Lid removal ..	2	1766	2399							

difficulties in measuring time to the nearest second, may not even reflect facts about the wasp, but may be 'noise' due to imperfect recording. In these data we noticed that foundation building of cell X contained 5 periods shorter than the median for all cells, and 9 not only longer but of 50 or more seconds. When the data from cell X are omitted, the median falls by 1 second to 44.3 and the standard error to 1.74, apparently solely because the median has been shifted away from the region of slight irregularity. However, neither in building the walls of cell X, nor during the subsequent daubing of cell IX, was there any similar slowing of work. Indeed, no long term or short term trend could be detected in the speed of any activity.

Estimate (2) was calculated from the formula $0.929 \frac{\text{I.Q.R.}}{\sqrt{n}}$ which was obtained as follows. Assuming that there is a normal distribution between the quartiles, we have I.Q.R. = 1.349 × *standard deviation.* And since the median ordinate f_c for a normal distribution is ($n\sqrt{2\pi}$. standard deviation)$^{-1}$ the standard error of the median is estimated by

$$\frac{1}{2\sqrt{n}.f_c} = \frac{\sqrt{2.\pi}}{2\sqrt{n}}\sigma = \frac{\text{IQR}}{1\cdot 349}\sqrt{\frac{\pi}{2n}} = 0\cdot929\frac{\text{IQR}}{\sqrt{n}}$$

The standard error of 44.3, the median value of foundation building for cells I to IX, is, on formula (2), 2.97.

Tables VI and VII classify the activities according to whether the

TABLE VI

Operation	Block daubing	Lid daubing	Smoothing	Wall	Found-ation	Lid
Block daubing						
Lid daubing						
Smoothing ..	s *s* S	*s*				
Wall ..	s *s* S	*s* S	s *s* S			
Foundation ..	s *s* S	*s* S	s S			
Lid ..	s *s*	*s*	s *s*			

NOTE.—For explanation see p. 22

differences between the times they took exceeded 3 times their relevant standard errors according to the various estimates [s=significant on the mean, *s* on estimate (1) of the s.e. of the median and S on estimate (2)]. The results are in fair agreement. These figures verify

and quantify that the various parts of cell construction ; i.e. *foundation, walls*, and *lids*, take longer to perform than *lid daubing* and the general, or roughcasting, *daubing* that blocks the cells up, even though, during wall and lid making, the movements seem more stereotyped and decisions dependent on immediate stimuli seem to play a lesser part. That *smoothing*, suggested to be for camouflage, takes less time than the structurally essential foundations has already been commented upon.

However the time taken to *fetch* the mud for these two apparently more instinctively elaborate movements requires a longer journey (Table VII). This may be because it is special mud brought from a

TABLE VII

Operation	Smoothing	Block daubing	Found-ation	Wall	Lid daubing	Lid
Smoothing						
Block daubing						
Foundation	*s*					
Wall	*s* S	*s* S				
Lid daubing	*s* S	*s* S				
Lid	*s* S	*s* S	*s* S	*s* S		

NOTE.—For explanation see p. 22

greater distance, or selected with greater care, or it may be more worked at the place of collection. Though *lid daubing* is a rapid process the mud used seems to be the ' long-distance ' mud used for the lid itself. This may have some mechanical efficiency, or may reveal that the wasp was undecided as to its use while collecting it, or in some other way reveal a transitional stage. However no trend could be detected suggesting that the wasp gradually changed its methods of mud collecting as it entered a period of exclusive daubing and smoothing. Similarly though the times taken to fetch mud for foundations were more variable than for other chores, this was not because the animal was using one sort of mud for these foundations when laid down alternately with daubing and smoothing, and another immediately preceding wall-building. During the demolition of the nest some differences could be seen between cell mud and daub mud, but these differences were not of the kind that demonstrated that they must have had different sources. The two muds remained stuck together and did not fall apart when chipped, though daub mud seemed to contain more brick dust.

Concerning the wasp's other chores, the figures are less easy to generalise. The shortness of the duration of the visits classified as 'doubtful prey' is precisely the reason for the doubt about them; the animal moved too quickly for an adequate view to be obtained by the observer. On 13 occasions the wasp was away over 5 minutes before she brought back mud, but only once was she away over 30 minutes. This last absence was not due to rain. During these long periods she cannot have been exclusively occupied with mud collection. However before returning with prey she was 21 times away longer than 30 minutes. Some of these delays were certainly due to rain, and some may be due to the elusiveness of prey; but she ignored spiders in the room, and even on the table itself. The median of the durations of absence during the provisioning periods before a cell was sealed with a temporary concave lid was smaller than the median of the absences during such periods before permanent closure, but not significantly so, i.e. there is no suggestion that a temporary lid was put on because spiders were being difficult to find or catch.

There were 70 absences of over half an hour, including the nights, and after 48 of these she brought no load. It seemed that periods of absence of somewhere between 30 to 60 minutes made it more and more likely that some inspection was necessary to refresh her memory before she could resume work. There are three absences of more than 1 hour where she is recorded as bringing a load, but one of these being 'doubtful prey', cannot be stated definitely to have involved a load. The other 2 were ovipositions, i.e. the activity where the wasp's own physiological condition would be expected to play the greatest part in jogging her memory, or of making any but special memory unnecessary. Six other ovipositions were performed after half an hour, and only twice was it attempted after less than 15 minutes' absence. A long absence before an oviposition seems characteristic, but no single explanation will fit all the cases. Sometimes this delay looked as though a newly built cell was being allowed to dry, but this would not explain comparable absences when the cell had been built overnight and only inspected in the morning; also the egg was placed in cell VIII only 262 seconds after the last load of mud had been added to the walls. On the two occasions when oviposition was repeated the absences between the failure and the success were 2316 and 1065 seconds. The spiders used were too heterogeneous to suggest that a particular species must be used to receive the egg, and time must be taken in finding it.

Some at least of the species of the genus *Ammophila* maintain several separate cells in different stages of development at the same time (Baerends 1941). It is possible that our wasp may have been attending to other nests during the longer periods of absence. This can only be decided by marking animals, but the observation that the activity

of our wasp on this nest rose to a definite peak would be compatible with her having started this nest before she finally finished and sealed a former, which she was servicing during her absence on the sunny afternoons of 15/7 and 16/7, and also of starting another which she was attending during the fine afternoon of 26/7. If our suggestion about the time of insemination or of the beginning of fertilization (p. 15) is correct, the nest finished on 16/7 would contain an all male brood, and that begun on 26/7 an all female. We do not know if such unisexual nests occur. Such nests have been recorded (Jayakar 1963) for *Eumenes esuriens*.

IV. Discussion

The difference between this and previous accounts of wasps belonging to the genus *Sceliphron* have been indicated already. We do not think they need further discussion. This, we think, should await similar studies *both* on other individuals of *S. madraspatanum* and on other species of wasp. In morphological studies the proper appreciation of both intra-specific and inter-specific variation is emphasised. Such an approach is not yet a routine in the study of biological function, even in those fields, such as genetics, which have stimulated statistical methods. Statistics are usually used, as in this present work, to confirm, or not confirm, the existence of differences which were suspected for other reasons, e.g. as being due to ancestry, sex, or external conditions; and, at least in studies of behaviour, emphasis is now being put on carefully defining a hypothesis as a preliminary to collecting the data intended to disprove, or fail to disprove, it. We would like to suggest an extension of the discipline that if a phenomenon is worth watching it is worth noting, into the discipline that if a phenomenon is worth noting it is worth counting as many features of it as the observer can think of. Such an undesigned and exploratory use of statistics would certainly provide surprises of discovery and interpretation. However, it is essential to put in the strongest plea that to contribute to the approach we have in mind, a paper without numerical tables is perhaps more enfeebled in its aim than is an anatomical paper without pictures.

By the criterion of species specificity, and almost certainly of lack of opportunity for imitation, this nest building must be considered an instinctive activity. However, we have been unable to hypothesise any relevant sign stimuli, nor recognise any comparable, or reciprocal, stereotypy in the form of movements. This failure is probably due to the difference between the senses of the observers and the observed. Is it because we could not imagine her antennal sense (or senses) that our wasp seemed so intelligent and purposeful?

V. Summary

One nest of *Sceliphron madraspatanum* consisted of 10 cells the first 4 of which contained males, the next 5 females. The 10th cell was left unsealed, so the larva fell out. Only one period of building was not watched. This probably consisted of about 30 visits. Of the 955 visits seen, 948 were timed to the nearest second. Mud was brought on 772 visits. Of these 426 were spent in building individual cells. 277 more were occupied in daubing the construct as a whole, and 69 with smoothing mud on the surrounding wood. About 10 seconds or 25% longer was required to fetch mud used in cell construction than for the two more general activities which were performed together during six periods roughly alternating with the building of one or two cells.

On 64 visits a spider was brought, including 1 too big to be introduced. The times taken to find prey ranged from less than 3 minutes to nearly 1¾ hours. The egg was laid on the first spider introduced into the cell. On 19 visits we were uncertain if anything was brought, but on 3 visits flies were introduced, confirming that these form part of the food of some species of this genus.

On 97 visits no load was brought. These included the first of the day, most of those after an absence of longer than an hour, and on 5 days the last. On 6 days the wasp removed a temporary lid on the first or second visit. On most visits the animal swept the construct with her antennae, wiping these on the first pair of tarsi.

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Wildlife Sanctuaries of Rajasthan

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(*With two plates*)

Rajasthan has established eight Wildlife Sanctuaries for the casual observer, the naturalist, and the wildlife photographer and is managing them on scientific lines. The paper gives a short description of each.

INTRODUCTION

Rajasthan ranks high in wildlife potential. Its pleasant climate for the greater part of the year, dry deciduous forests, open patches of growing grass, and the agricultural pattern provide an excellent habitat for wildlife. The long leafless period, the dried-up undergrowth, and the few waterholes form an ideal combination for wildlife observation and photography.

The State is situated between 23.3° and 31.12° N. and 69.30° and 78.17° E., and extends over 344,000 hectares. The south and south-eastern parts are hilly; the north and north-western regions form the true Indian desert. The climate is characterised by hot weather during May and June when the temperature rises to 108° F. The winters are pleasant. The desert areas exhibit extremes of temperature; sometimes it rises to 123° F. (Pachpadra) in May and falls to 24° F. (Jaisalmer) in January. Rain is uncertain and scanty. The average rainfall is 25 in. and rainy days are hardly 20 to 30 in the year. Sometimes the whole year passes without a single drop of rain.

The vegetation changes from the tropical semi-evergreen forests of Mt. Abu, the tropical dry deciduous teak (*Tectona grandis*) forests of Banswara, and the tropical dry deciduous *Anogeissus pendula* forests of the Aravalis to the tropical dry deciduous thorn forests of the desert zone. In the extreme north, there are only shifting sand

dunes and scrub of *Calligonum polygonoides, Leptadenia spartium*, and *Calotropis procera*. The agricultural pattern changes from the intensive rice cultivation of Doongarpur and Baran to the 'mere gamble' with a handful of bajra seed in the sand dunes of the desert region. Animal husbandry is extensively practised in the west; large herds of sheep, goat, and camel are maintained and the people lead a nomadic life.

The State presents an interesting collection of animals and birds, including Tiger (*Panthera tigris*), Panther (*Panthera pardus*), Caracal (*Felis caracal*), and Sloth Bear (*Melursus ursinus*). Chinkara (*Gazella gazella*), Blackbuck (*Antilope cervicapra*), and Nilgai (*Boselaphus tragocamelus*) are fairly common and prefer the drier and open areas. Chousingha (*Tetracerus quadricornis*), the only species of its genus, is another antelope met with. They live near waterholes. Sambar (*Cervus unicolor*) and Chital (*Axix axis*) are found in the forest areas of the inner Aravalis and the Vindhyan ranges. Their distribution is more marked in the Chambal ravines from Kota to Dholpur. Hyena (*Hyaena hyaena*), Jackal (*Canis aureus*), Indian fox (*Vulpes bengalensis*), Mongoose (*Herpestes edwardsii*), Jungle Cat (*Felis chaus*), Common Palm Civet (*Paradoxurus hermaphroditus*) are common. Wolves (*Canis lupus*) and desert fox (*Vulpes vulpes pusilla*) are confined to the desert areas. Indian Hare (*Lepus nigricollis*) and Desert Hare (*L. nigricollis dayanus*), Porcupine (*Hystrix indica*), and a large variety of gerbilles, rats, mice, etc. are the common rodents found in the State. Indian Pangolin (*Manis crassicaudata*) has also been reported from a variety of habitats.

The avifauna of the State is even richer. It is the true home of the peacock (*Pavo cristatus*), the Great Indian Bustard (*Choriotis nigriceps*), and the blue rock pigeon (*Columba livia*). Resident game birds, like grey partridge (*Francolinus pondicerianus*), Indian Sandgrouse (*Pterocles exustus*), Painted Sandgrouse (*P. indicus*), quail (*Coturnix* spp.), green pigeons (*Treron phoenicoptera*) are quite conspicuous. Large numbers of migratory birds arrive during winter. The commonest of them are duck, teal, geese, cranes, Imperial Sandgrouse (*Pterocles orientalis*), Houbara (*Chlamydotis undulata macqueenii*), Florican (*Sypheotides indica*), and many wagtails, bushchats, larks, starlings, etc.

Formerly wildlife was strictly preserved in the various States of Rajasthan, but it was mainly for the sport of the princes. At times, wild boar, chinkara, sambar, and even tiger and panther were preserved at the cost of the poor farmers, for which they never got any compensation. Since the old order has changed, a new concept

must prevail. If wildlife is to be preserved, it has to be at State cost, within State limits, for the benefit of all and without interfering with the rights and privileges of the individual.

The State Government is conscious of the new concept and harmful species have been posted as pest or vermin, and others facing extinction have been notified as protected. Large tracts of State forest (*c.* 270 sq. miles) have been notified as reserved areas, where shooting, hunting, netting, trapping, etc. are strictly prohibited. The eight reserved areas are: Sariska in Alwar; Van Vihar-Ram Sagar, and Ghana in Bharatpur; Sawai-Madhopur in Sawai-Madhopur; Darrah in Kota; Jai Samand in Udaipur; and Mount Abu in Sirohi district. They are popularly known as Wildlife Sanctuaries where special arrangements have been made to develop and protect the animal life of the area. To this list, two more are to be added shortly, one at Talchaper in Bikaner for the preservation of Blackbuck and the other in Jaisalmer for the Great Indian Bustard.

SARISKA

Sariska is Rajasthan's outstanding Wildlife Sanctuary. It is situated on the National Highway No. 8 (Delhi-Jaipur) 125 miles from Delhi. It extends over approximately 80 sq. miles of forest. Dhok (*Anogeissus pendula*) is the main species of these forests but pure stands of Salar (*Boswellia serrata*) grow on the steeper and drier slopes. Bottom lands support Dhak (*Butea monosperma*), *Zizyphus* spp., and Khair (*Acacia catechu*). The forest covers three main valleys: Kalighati, Siliberi, and Sariska. These valleys have wooded hill slopes and the landscape of rolling hills presents a picturesque setting (Plate I).

The sanctuary is rich in wildlife. Sambar, nilgai, chousingha, chinkara, wild boar, tiger, and panther are common and can be conveniently seen from the sanctuary roads or from observation towers. Special arrangements have been made to show tigers on the kill under searchlight from safe and comfortable machans. For bird watchers the sanctuary is still more interesting. Partridge, quail, and sandgrouse, which are normally very wary, move quite freely on the roads and paths. Other birds, like peacock and green pigeon, are quite common.

The sanctuary is well netted with fair-weather roads. One enjoys the rare sight of sambar, herds of nilgai, and wild boar retreating to the hills from pastures in the morning, whereas night drives open the entire jungle book page by page.

Sariska is historically important also. The recent excavations of *Garh* are attracting a number of amateur archaeologists. The new finds are old temples of the tenth century A.D. The abandoned fort of Kankwari is another historical place where Dara got asylum when Aurangzeb was hunting for him.

Sariska is very popular, being easily reached by road. The well-furnished forest rest houses are electrified and cater for the visitors' comfort.

Van Vihar-Ram Sagar

Van Vihar and Ram Sagar, the finest shooting blocks of the late Maharaja of Dholpur, were very rich in wild life. His interest in wild animals and birds was so great that his evening drive to feed the creatures was a *must*. He would take various types of food to feed sambar, chital, chinkara, and even tiger, panther, and jackal from the roadside. Coveys of partridges used to await the Maharaja's arrival.

This preservation received a fatal blow during the transitional period of the transfer of political power and the integration of the princely States. Very many of these semi-tame creatures were massacred by poachers. In 1955, however, these were made reserved areas under the Rajasthan Wild Animals and Birds Protection Act, 1951.

These reserved areas are now popularly known as Van Vihar and Ram Sagar Wildlife Sanctuaries. Since the sanctuaries have similar fauna, flora, and topography I have treated them as one unit and described them as Van Vihar-Ram Sagar Sanctuary. The Sanctuary is situated 170 miles from New Delhi and about 50 miles from Agra. It is connected with Delhi-Madras National Highway No. 3 at Dholpur by a 12-mile link road. It extends over 20 sq. miles of low and well-clothed hills of the Vindhyan series. The forest consists of pure crop of Dhok with Khair as its principal associate.

The well-furnished and electrified forest-lodge of Van Vihar overlooks a small lake where herds of chital, sambar, and wild boar come to drink even during the day. They come close to, and provide chances for easy photography from, the lodge terrace. A visit to Shahjahan's hunting lodge and boating in the Ram Sagar lake are really interesting.

Darrah

The Sanctuary is situated 30 miles south of Kota City on Kota-Indore road in the well-wooded Girdharpura Valley. Dhok, Khair,

Dry deciduous forest—Sariska

Photo : K. S. Sankhala

Tiger at kill—Sariska

Sambar at waterhole—Van Vihar

Photos : K. S. Sankhala

Dhak, Karaya (*Sterculia urens*), Bahera (*Terminalia belerica*), Tendu (*Diospyros melanoxylon*), Gurjan (*Lannea grandis*), Khirni (*Wrightia tinctoria*) are some of the common trees of the sanctuary. It is famous for chital, nilgai, wild boar, sambar, bear, and tiger. Panther and chinkara also occur. Spurfowl, black and grey partridge, and quail are seen everywhere. Old forts, a museum, the Gandhi Sagar Dam, the Kota Barrage, and big game shooting in Kota forests are some of the other attractions.

Sawai-Madhopur

The Sanctuary is situated about 6 miles to the east of Sawai-Madhopur Railway Station. It extends over 60 sq. miles of well-covered rolling hills, flat tops, and narrow valleys of the Aravali ranges. The forests consist of pure crop of Dhok with Khair and Tendu as its associates. The sanctuary abounds in sambar, chital and nilgai, tiger and panther. Wild boar, sloth bear, and chinkara are also found.

The sanctuary is approachable by road from Jaipur only during non-monsoon period. Several fair-weather roads connect all the areas of the sanctuary but they open only after December. The historic and invincible Ranthambhor Fort of Rana Hamir, situated in the heart of the sanctuary, is a big attraction for tourists.

Jai Samand

The Sanctuary is situated 32 miles south of Udaipur City on Udaipur-Salumbar road. It extends over 20 sq. miles covering well-clothed valleys and hill ranges of the innermost Aravalis. The forests support mainly Dhok and Salar with scattered trees of Semal (*Salmalia malabarica*), Gurjan, Karaya, etc. on the hill slopes, and a miscellaneous crop of Dhak (*Butea monosperma*), *Terminalia* spp., Mahuwa (*Madhuca latifolia*), *Bridelia retusa*, and bamboos in the valleys.

It is famous for chinkara, chital, sambar, bear, panther, and wild boar which can be seen while driving on the Sanctuary roads. Stray tigers are also met with. Grey partridge, spurfowl, and quail can be seen on the Sanctuary roads.

Jai Samand Lake is situated on the eastern boundary of the sanctuary and provides good boating facilities.

Mount Abu

The Sanctuary is situated on the plateau of Mount Abu, extending over 40 sq. miles of sub-tropical evergreen forests. The main species occurring are *Anogeissus sericea, Mangifera indica,* Khajur (*Phoenix sylvestris*), Bar (*Ficus bengalensis*), and shrubs like *Carissa spinarum, Caesalpinia* spp., and *Zizyphus* spp. The topography is characterised by deep, well-wooded valleys, steep mountainous slopes, and huge granitic boulders scattered all over. Wildlife consists of sloth bear, panther, sambar, chinkara, and chital, and occasionally a tiger. Grey junglefowl, crested tits, bee-eaters, bulbuls, shrikes are some of the conspicuous birds. Since the sanctuary has been created very recently, it is still in the making.

The nearest rail-head is Abu Road on the Delhi-Ahmedabad metre-gauge line. It is 18 miles from the sanctuary and is well connected by bus and taxi services.

Mount Abu is famous for its pleasant and healthy climate throughout the year. Delwara and Achalnath Jain temples are other big attractions for the visitors. Guru Shikhar, 5653 ft. above m.s.l., makes an enjoyable excursion.

Ghana Bird Sanctuary

The heronry has attained international fame and is a show place for visitors and tourists in general, and of particular interest to ornithologists and bird photographers. It is a low-lying freshwater marsh which is flooded during rains. It is well wooded with medium-sized Babul (*Acacia arabica*) and Ber (*Zizyphus* spp.). There are a few tall Kadam (*Mytragyna parvifolia*) trees, where eagles, hawks, and whitenecked storks nest. Numerous cormorants, egrets, spoonbills, darters, storks, herons arrive and nest on the trees during the rains. Thousands of migratory duck, teal, cranes geese, even Siberian cranes, arrive during winter. The whole atmosphere is filled with duck calls and occasional crane trumpets during winter.

It is situated 30 miles from the Taj and 110 miles from New Delhi on the Delhi-Bombay rail route of the Western Railway. At the nearest railway station Bharatpur, only 4 miles away, local transport is always available. There is a good network of roads and all places in the sanctuary are within walking distances. Small canoes make it possible to reach almost every nest. In evening drives herds of nilgai, chital and blackbuck can be seen from the sanctuary roads.

The table opposite shows the best time to visit the sanctuaries.

WHEN TO VISIT THE SANCTUARIES

Name of Sanctuary	Time to visit		
	Most Suitable	Moderately Suitable	Not Suitable
1. Sariska ..	16th Feb.-30th June	16th Oct.-15th Feb.	15th July-15th Oct.
2. Van Vihar-Ram Sagar ..	8th Feb.-30th June	1st Nov.-7th Feb.	1st July-31st Oct.
3. Darrah ..	16th Feb.-30th June	16th Nov.-15th Feb.	1st July-15th Nov.
4. Sawai-Madhopur ..	16th Feb.-15th June	1st Dec.-15th Feb.	16th June-30th Nov.
5. Jai Samand ..	1st May-30th June	16th Dec.-30th April	16th June-15th Dec.
6. Mt. Abu ..	16th April-15th June	(i) 1st Oct.-30th Nov.	1st July-30th Sept.
		(ii) 16th Feb.-15th April	1st Dec.-15th Feb.
7. Ghana ..	16th July-31st Oct.	1st Nov.-15th July	

Management

The Sanctuaries are State institutions within the Forest Department. There are Game Wardens for Sariska, Van Vihar-Ram Sagar, Darrah, Jai Samand, and Mount Abu, and Game Rangers for Ghana and Sawai-Madhopur. Above them are the Divisional Forest Officer, the Conservator of Forests of the Circle, and the Chief Conservator of Forests.

The Sanctuaries are effectively protected by a team of Game Watchers posted at the entrances. A few batches guard the inside and Game Wardens on motor cycles and jeeps patrol the entire area. Roads entering the sanctuaries are opened only by the order of the officer-in-charge of the sanctuary. Visitors have to register their names and addresses and the purpose of the visit at the sanctuary gates. No firearm may be taken without the permission of the officer-in-charge.

The old shooting boxes situated in the sanctuaries have been renovated and made into observation towers. Since they are quite commodious and safe, they function as ideal dormitories. Some new types of observation posts have been recently constructed.

During adverse conditions of food and water, the animals are well looked after. Water troughs have been constructed which act as waterholes in summer. At places artificial feeding is done. The staff keeps a close watch on the wildlife of the area and works out the population trends. It is hoped that the records of the observations made will help in the scientific management of the sanctuaries.

Special facilities have been provided for photographing wildlife. At Sariska, live bait is put out every Friday evening, and visitors can see and photograph tiger at a kill. Similar arrangements are made on request in other sanctuaries. Amateur photography is free but professionals are required to pay fees.

There are well-furnished and electrified forest rest-houses at Sariska, Van Vihar, Ghana, and Mount Abu. At Jai Samand there is a good forest rest house and P.W.D. dak-bungalows at Sawai-Madhopur, and Darrah. Forest rest houses are booked by the respective sanctuary officers. The P.W.D. Dak bungalows are reserved by the Collectors of the districts. The Divisional Forest Officer of the area can be fully depended on for necessary assistance and information.

Notes on the outcome of literature survey for *Wealth of India—Raw Materials*

BY

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A comprehensive survey and scrutiny of the literature published during the past 60 years on economic plants, which form the major part of the 'wealth of India', have revealed certain interesting and valuable points, a few of which are presented here. Those selected for presentation pertain to the accuracy, adequacy, and availability of information.

ACCURACY OF PUBLISHED INFORMATION

The literature available in some cases was extensive, in some not enough. Quite often the information was confusing, owing to lack of precision in identifying the source materials or in reporting their distribution or economic properties. In some cases, clear evidence was available that strict botanical identification of the plants or plant materials was not done at the time of investigation or even when the results were sent for publication. In some cases, samples emanating from different sources were erroneously considered to be the same, since they apparently looked alike in external features or had the same regional or local names; in other cases the same material was considered different, owing to differences in local names or difference in appearance brought about by soil, and climatic and cultural factors. In the absence of a concomitant field survey of the actual materials investigated, the task of evaluating and summarizing such published results posed certain problems.

Botanical Nomenclature

One of the chief problems in the compilation of articles on plant products has been the correct botanical identity of the genera and

species. Recent researches in systematics and taxonomy have revealed several errors in the identity of the plants recorded in India. In earlier literature, some of the plants occurring in India have often been considered as identical with those known from Europe, America, Africa, or eastern Asia. Consequently, the economic uses known for them in those areas have been attributed to the plants recorded in India. Recent investigations show that some of these plants are quite different from one another and consequently the economic uses attributed to one cannot hold good for the other. Further, analyses of Indian specimens have shown differences in structure and composition from the European or American plants, evidently due to variations not only because of specific differences, but also of soil and climatic conditions. An interesting example of this type is furnished by *Fumaria officinalis* Linn. and *F. parviflora* Lam., small herbs found in Europe and SW. Asia; they are the sources of the drug *Fumitory* used in stomach derangements, liver complaints, and skin affections. The drug which is sold in Indian bazaars under the name *Shahterah* or *Pitpapra* had been for a long time referred by most of the Indian authors to one or the other of these two species. It has now been shown that the common Indian species is *F. vaillantii* Loisel, and the Indian drug obtained from it is, at best, only a substitute for true *Fumitory*.

Another example of this type is furnished by *Cinnamomum zeylanicum*, the leaves of which yield the cinnamon oil of commerce. In earlier literature, the plants found wild in S. India were classified under this species and were considered to be only a variety or race. The oil extracted from the Indian plants was also classified as of *C. zeylanicum*, although differences were noticed in certain characteristics, particularly the eugenol content. Later investigations suggest that the common Indian plant found wild is probably *Cinnamomum iners* and that *C. zeylanicum* occurs perhaps only in cultivation or, in some places, as an escape. The botanical differences between the species are minor and not yet quite clear, and whether the differences in composition of the oil are really due to differences in the specific nature of the plants is yet to be solved.

Very few plants can equal *Mung* and *Urd* in the amount of confusion due to the misidentification and misinterpretation of their specific names and one author trying to correct the mistake of another. The genus *Phaseolus* was established by Linnaeus on the basis of the common French Bean (*Phaseolus vulgaris*) which is American. He referred to this genus our pulses like *Urd* and *Mung*, although they differed in some essential botanical characteristics from

the French Bean. He applied the name *Phaseolus mungo* to specimens which he presumed were of *mung*, but which were actually of *Urd*, and applied the name *P. radiatus* to *mung*. Roxburgh tried to correct this by reversing the names; Roxburgh's *P. mungo* is *Mung* and *P. radiatus* is *Urd*. Baker in Hooker's FLORA OF BRITISH INDIA followed Roxburgh in designating green *Mung* as *P. mungo*, and *Urd* as a variety, var. *radiatus* of *P. mungo*. Watt (1892) in A DICTIONARY OF THE ECONOMIC PRODUCTS OF INDIA followed Baker. Prain, and later Piper, showed the mistake made by Roxburgh and suggested restoration of the Linnean name to *Urd*. Watt (1908) in THE COMMERCIAL PRODUCTS OF INDIA followed this suggestion, thus reversing what he had done in his previous work. As a consequence of this confusion in these standard works of reference, in all subsequent papers on these pulses the names have been used indiscriminately, so that one is often unable to know which pulse is really meant. To add to this confusion Piper, following a suggestion from Prain, adopted the name *P. aureus* Roxb. as the name for *Mung*, though it applied only to the golden yellow type known as *Sona Mung* and not the common *green mung*. Examination of seed samples of both these species has revealed, further, that green-seeded *urd* are also present, while there are also black-seeded *mung*. As a result of these variations in external characters and the misapplication of specific names, a large part of work done on these pulses becomes difficult to assess correctly and to say how far variations in quality and consumer preferences, shown in different places, are related to these variations.

Indian Names

Another aspect of plant nomenclature which attracts one's attention is the constant confusion brought about by the use of Indian language names, even in scientific communications of recent dates, without reference to the correct botanical names. Indian names are mostly group names, often indiscriminately applied to products of similar appearance or use, rather than of the same origin. Because of the indefinite nature and indiscriminate use of Indian names, confusion has been brought about in the literature on the nature and utilization of many plant products. As an outstanding illustration may be pointed out the fruits of a plant, known commonly as *Sugandh Kokila*, used as a source of an essential oil in perfumery. It was found that this name has been applied to two or three different plants, one of them *Luvunga scandens* (Rutaceae) and another *Laurus nobilis* (Lauraceae). Examination of the literature revealed that the fruits obtained under this name from certain

markets in U.P. yielded an oil having different chemical composition from the one recorded earlier under the same name from eastern India. On verification of samples and correspondence with the authors of the papers, it was found that the fruits from U.P. markets were not properly identified and they did not belong to the species to which they were attributed. Further, the fruits evidently belonged to an entirely different plant, other than the one reported from eastern India. Samples sent to the Forest Botanist, Dehra Dun, were identified as belonging to *Zanthoxylum* and not to *Luvunga* or *Laurus*. According to the literature available, *L. scandens* does not occur at all in the hills of U.P. or the western Himalayas from where the material was reported to be collected, while *L. nobilis* is known in India only from a few introduced plants occasionally cultivated in gardens. The scientific results of the two investigations, though recent, had to be discarded owing to the indefinite nature of the plant sources.

Crop Plants

A scrutiny of the literature pertaining to crop plants shows a larger amount of confusion, lack of understanding of present day knowledge, and sometimes even carelessness. In many of the publications no attempt has been made to get an unqualified identification of the species dealt with or their varietal positions, particularly when there are numerous cultivated types. In many cases, confusion has arisen from the identification as different species of plants which are purely specimens of a hybrid population. There are many reasons for this confusion, not the least being the lack of interest of taxonomists in economic crops. Most of the economic botanists appear to have been interested mainly in the utilization rather than in the botanical aspects of the plant. The taxonomists on the other hand have often avoided crop plants because of their high variability and the presence of intergrading forms, hybrids, mutants, abnormalities, etc. In recent years, considerable work has been done towards clarifying these variants based on taxonomic, cytogenetic, and phytogeographical surveys, elucidating their place of origin, domestication, classification, and distribution. However, very little of this work has found reference in standard works for agriculture or horticulture. As a consequence, some economic botanists even now continue to use the old names, perhaps owing to a conservative outlook. In many of the papers published in agricultural and horticultural journals it is not uncommon to find the botanical name of the plant missing or, if given, not only incorrect and old but often

misspelt and misapplied. Examples of these have been noticed during the compilation of articles on *Canavalia, Citrus, Elettaria, Fragaria, Gossypium, Mentha, Musa,* and *Phaseolus,* to mention only a few.

In the case of the genus *Mentha,* it was found that most Indian authors refer the common Mint (*Podina*) cultivated in India to *M. viridis* Linn., a name already shown in floristic works as synonymous with *M. spicata* and probably comprising a large number of variants. While surveying the literature, doubts arose regarding the possibility of one or more variants of this species being present in India owing to certain differences recorded in analyses of the essential oils obtained from plants from Poona and Kanpur stated to be of *M. viridis.* Kanpur samples had 55.8% of carvone, while Poona samples had nil and contained only a terpenic glyoxal ($C_{10}H_{14}O_2$), a constituent somewhat like piperitenone oxide present in an allied species, *M. rotundifolia.* According to present day knowledge, the latter species is one of the parents of *M. spicata,* which is considered a hybrid species. An analysis of floristic records in India and also some specimens grown in New Delhi, pointed to the fact that the specimens examined at Kanpur and Poona are probably variants of a hybrid progeny not fully identified. This is an instance where a careful scrutiny of the source material is needed, even down to a varietal or racial level, in order to explain the differences.

Adequacy of information

Coming to literature scrutiny with reference to adequacy of information, it was found that in some cases published information appeared large, but closer scrutiny revealed that some of the later contributions were repetitive of what had been published earlier, often emanating from Watt's work. In these cases the information already known was simply reclassified under various end uses or regionwise, without any material advance. On the other hand, in some cases, unnecessary confusion has been caused by inadvertent misinterpretation and misquoting of the earlier information; in some cases individual opinions, often cautiously expressed, have been stated as fully established facts.

A large number of papers purport to record useful plants in the different areas studied. While they give some useful information regarding places of occurrence, most of the uses attributed to them appear to be based on observations recorded earlier. To cite a few examples, publications like Rama Rao's FLOWERING PLANTS OF

TRAVANCORE, Dastur's USEFUL PLANTS OF INDIA AND PAKISTAN and MEDICINAL PLANTS OF INDIA AND PAKISTAN, Bal's 'Useful Plants of Mayurbhanj in Orissa' [*Rec. bot. Sur. India,* 1941, **6** (10) : 1-119], Jain & Puri's 'Survey of some oil-yielding plants of Western India'. [*Bull. bot. Sur. India,* 1960, **2** (1 & 2) : 95-98], etc. give hardly any new information. It would have been more useful if some of these records were based on actual observations freshly made, so that confirmatory evidence would be available. Some of these publications do not indicate even their sources of information.

On the other hand, intensive studies and surveys of small areas have shown more interesting particulars not known earlier and have helped to correct some older information. To cite an instance, it has been recorded in Watt's A DICTIONARY OF THE ECONOMIC PRODUCTS OF INDIA that fruits of *Olea dioica* and *Careya arborea* are edible and almost all the later authors have repeated this information. Recently Fr. H. Santapau while surveying the Flora of Khandala refuted these statements and recorded that fruits of *Olea dioica* are intensely bitter to taste and are at the most eaten by some animals, while fruits of *Careya arborea* have a foul smell and even birds and animals hardly touch them. He also recorded that fruits and seeds of *Dolichos bracteatus,* a plant growing wild in the Western Ghats, are collected and used for edible purposes, a fact not known earlier. Such intensive studies should be made of other areas in India and factual information collected to substantiate or refute old beliefs and practices.

A glaring instance of an error committed inadvertently in a publication and perpetuated by later authors was found with reference to the perennial herb, *Glycyrrhiza glabra* Linn., the source of Liquorice (*Mulhatti* or *Atimaduram*). The plant is distributed in the Mediterranean region, and SW. and central Asian countries; most of the bazaar samples sold in India are from imported materials. On the doubtful information of its occurrence or cultivation in Peshawar valley (now in W. Pakistan) one of the earlier Indian authors tried to convey that it is met with in the sub-Himalayan tracts from Chenab *westwards,* but erroneously stated *eastwards.* This error has been perpetuated by all subsequent authors, leading naturally to the belief that the plant is found throughout the sub-Himalayan tracts. Actually the plant does not occur wild anywhere in India and is only being experimentally grown in some places.

Another example, though of a slightly different nature, is *Polygala chinensis* Linn., a small herb occurring plentifully in many parts of India. On the basis of unauthenticated studies on roots supposed to have been derived from this plant, it was for many years considered

a suitable substitute for the American *P. senega* Linn., the roots of which constitute the drug senega used as an expectorant in bronchitis and asthma. Consequently, the roots of *P. chinensis* were made official in THE INDIAN PHARMACOPOEIAL LIST, 1946, and PHARMACOPOEIA OF INDIA, 1955. Recent studies have revealed that all commercial samples of Indian senega are spurious and are derived from plants not even belonging to the genus *Polygala.* Indian senega and its preparation have now been deleted from the Indian Pharmacopoeia.

A survey of the literature pertaining to the medicinal uses of plants has often raised doubts about the usefulness and authenticity of much of the information published. For a fairly large number of them no examination has been made of their pharmacological properties nor have clinical trials been conducted to substantiate their virtues. Some of the uses and properties attributed to these plants are vague as to the exact part used, whether used alone or in combination with other drugs, and the number of cases where they have proved efficacious. The opinion of an individual based on a single case has been taken as sufficient evidence to attribute to a plant certain medicinal virtues, although analysis of the plant showed nothing of merit in its composition. Examples of this are the various plants mentioned as useful for snake bite and scorpion stings and proved valueless by Caius and Mhaskar. A critical evaluation of the phytochemical properties, combined with pharmacological and clinical tests, based on properly identified materials is badly needed to substantiate many of the claims made of the medicinal properties of plants.

In this connection, reference may be made to some publications frequently consulted by all workers on medicinal plants, such as Kirtikar & Basu's INDIAN MEDICINAL PLANTS, Nadkarni's INDIAN MATERIA MEDICA, Chopra's INDIGENOUS DRUGS OF INDIA, Chopra *et al.*'s GLOSSARY OF INDIAN MEDICINAL PLANTS and INDIAN PHARMACEUTICAL CODEX. They are handy publications giving ready reference to the medicinal virtues of Indian plants, but they are mostly compilations based on previously published works. Some of them lack precision, particularly Kirtikar & Basu's work and Nadkarni's volumes, since they comprise data extracted from earlier publications where the identity of the source material is not clear. The medicinal properties based on Ayurveda and Unani systems are sometimes contradictory and raise doubts about the authenticity of the source materials. Further, in Kirtikar & Basu's volumes no attempt has been made to differentiate important and well-authenticated uses from uses based on individual opinions or stray cases. References to source of informa-

tion is also not indicated. Chopra *et al.*'s GLOSSARY suffers from the same drawback, because it is an abbreviated dictionary of what is stated mainly in Kirtikar & Basu. Nadkarni's works are more uncritical, since even the plant names and their distribution are often erroneous. As pointed out earlier, there is an urgent need for a critical evaluation of the medicinal properties attributed to many plants in these works.

AVAILABILITY OF INFORMATION

A scrutiny of the literature published so far reveals certain lacunae in the information available on certain Indian raw materials. For example, India is well known for its minor forest plants useful for food, fodder, or industrial purposes. However, there is as yet no source giving consistent data regarding their availability, demand, and extent of use. A rather surprising feature is that, while Watt was able to give some data regarding their availability and uses, based perhaps on special surveys, there is no machinery at present to authenticate and gather them consistently. Many of the forest trees yield useful dyes, gums and resins, fibres and floss, fats and oils, and medicinal products, for many of which demand always exists although in a small measure; a large number of queries received in the Directorate pertain to them. Many of these products if collected and processed can meet special requirements and can replace those obtained from cultivated plants or from outside India. A few examples are: minor oilseeds like Kamala (*Mallotus philipensis*), Nagkesar (*Mesua ferrea*), and Phulwara (*Madhuca butyracea*); minor fibres like Kittul (*Corypha*), Ramie (*Boehmeria*), and *Urena*; and medicinal plants like *Dioscorea deltoidea, Rauvolfia serpentina, Costus speciosus*, etc., etc.

Similarly, a large number of plants yield lesser-known edible fruits, which go to waste for want of a machinery to collect them in the proper season and preserve and market them. Some of them are known to have served people in times of scarcity and have considerable food and nutritive values; by proper utilization they can greatly supplement the food resources. A comprehensive survey of the food and nutritive values of minor edible plants is badly needed, so that at least those of value could be selected and processed.

Another important aspect of forest plants on which information has been found lacking pertains to the production and availability of timbers. While gross estimates are available, data regarding specific timbers of value is difficult to get and even correspondence with forest officers on this aspect does not yield tangible data.

A survey of literature on useful plants introduced into India at different periods indicates that sustained effort has been lacking in most cases, often leading to failure in getting them established. To mention a few cases, plants like *Elaeis guineensis* (Palm Oil Tree), *Olea europea* (Olive), *Chrysanthemum cinerariaefolium* (Pyrethrum), *Glycyrrhiza glabra* (Liquorice), etc., for some of which demand exists even today, have not been successfully established, either owing to lack of steady governmental support for experimentation on a long term basis or because of the climatic and edaphic unsuitability of the localities selected for their initial experimental cultivation. There is practically no literature or institution from where information regarding introduced plants is available, as to when they were introduced, what were the difficulties experienced in growing them in India, and why the attempts were not pursued.

In the literature on crop plants, a lacuna has been frequently noticed regarding the exact benefits bestowed by the introduction and evolution of improved types. While a large amount of literature was available of experiments carried out in Government farms, very little data could be gathered as to how far these types have come into general cultivation and in what way they have improved our total production and yield. The information is scattered in notes and news, annual reports of experimental stations, etc., with the result that a consolidated picture of their value is not available. The same holds good with regard to some of the trials with manures and fertilizers to augment yield.

Regarding the chemical composition and nutritive value of plants, much of the data available appears to be based on analyses done many years ago, either in India or abroad. In earlier years, the practice was to send the samples to the Imperial Institute, London, for examination and report, and much of the data is based on such analyses. Comparatively little work has been done in India on this aspect. In the case of cultivated food plants, comparative analyses of their composition and nutritive value are few, particularly of different market samples, with the result that their useful attributes are difficult to assess. Some of the grains are prepared or processed for human consumption, the processes varying in different parts of the country and with different end uses. The effect of such processing on the composition and nutritive value is little understood, and consumer preferences for certain types remain unexplained. In the case of medicinal plants and plants of industrial value, detailed analyses are wanting of Indian material. A co-ordinated botanical

and phytochemical survey of Indian materials is badly needed to fill up these gaps.

Another aspect which has come to light as a result of the survey of the production and trade data of some of the important commodities is the growing need to develop the utilization of by-products in order to offset the fall in the demand for our commodities in outside countries, owing either to higher prices or to the development of alternate sources of supply or substitutes. Thus groundnut, jute, linseed, and tobacco which used to figure prominently in our export trade have now been displaced in some of the markets owing to the high cost of our produce as compared with that of some other countries, particularly Africa, SE. Asia, North and South America. In order to maintain our competitive position, the utilization of by-products seems to need immediate attention. Incidentally, they may furnish articles for which there is need even inside the country. To cite a few examples, the price of jute can be cut down if jute waste is used for paper manufacture; sugar prices can be lowered if bagasse is utilized for paper-making.

An important aspect needing attention is the necessity for standardizing Indian trade names for important plants and plant products. With numerous languages and dialects in India a large number of names have been applied to the same product in different areas. With the internal trade now more widely based, it becomes necessary that Indian trade names should be standardized and strictly adhered to in Governmental and trade circles to facilitate their identification in cases of doubt and for collecting consistent data regarding their production, availability, and consumption.

In trying to collect illustrations to go with the articles, it was found that very little attempt has been made in recent years to provide accurately drawn sketches of economic plants. There has been a general tendency to reproduce illustrations published already in older publications, some of them of the eighteenth and nineteenth centuries. Quite often the same illustration has been repeated in a number of publications, even though the plant is common and a better illustration can be drawn afresh. The same may be said of even photographic reproductions. Repeated republication and copying of old illustrations sometimes results in perpetuating mistakes once made.

Though a large number of Indian plants are reported to possess medicinal virtues, there is yet no illustrated catalogue giving the important external and internal characteristics of the drugs, facilitating their identification. While drawings have been published of the entire

plant or flowering or fruiting branches, the essential parts used as drugs have not been illustrated. Similarly, no catalogue exists of seeds, fruits, or other parts of plant used as food, fodder, or spice; consequently their identification and verification have been difficult in cases of doubt.

CONCLUSIONS

To summarise briefly the important findings of the literature survey on plant products for WEALTH OF INDIA—RAW MATERIALS, the following may be stated:

1. There is a great need for accuracy and precision in the identification of the plant materials, in order to convey correctly their availability, properties, and proper utilization.

2. The need is also felt to assess afresh some of the properties attributed to many of our plant raw materials, not only to confirm what has been recorded earlier, but also to discover new ones. A correct assessment of their distribution and availability is necessary in order to facilitate their profitable exploitation. Projects based on a co-ordinated botanical and phytochemical study of the economic plants would be useful in throwing light on their intrinsic merits and clarifying some of their vague attributes.

3. A suitable central organization is needed to collect data regularly, regarding the availability and utilization of Indian plant raw materials and keep them up-to-date and make them available to scientists and industrialists.

Copepods parasitic on South Indian Fishes: Family Anthosomidae—2

BY

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(*With seven text-figures*)

[*Continued from Vol.* **60**(3): 670]

In two previous contributions (Pillai 1962, 1963) I have described eleven species from the present locality. The present paper describes seven species, all new, bringing the total to eighteen.

Genus **Lernanthropus** Blainville

Lernanthropus alatus sp. nov.

Text-fig. 8

M a t e r i a l. 6 females were collected by the author from the gills of two specimens of *Selaroides leptolepis* (Cuvier) at Trivandrum. Holotype, female, is deposited in the Indian Museum, Calcutta (Reg. No. C. 4440/1).

F e m a l e. Body short and stout. Carapace oblong, antennal area low but distinct, lateral lobes fairly broad and projecting in front as two rounded processes reaching well beyond the antennal lobe. Anterior division of trunk as long as, or slightly longer than, carapace, greatly swollen and expanded at the posterior two-thirds into large wing-like lobes with a small conical outer distal process. Dorsal plate as long as broad. Genital segment longer and broader than abdomen, abdomen proximally constricted and distally narrowed and bilobed. Anal laminae slender, longer than abdomen.

First antenna seven-segmented, basal segment expanded into a large irregular lobe projecting beyond the antero-lateral lobes of the carapace and holding the rest of the appendage fully exposed. Basal segment of second antenna stout, its inner and outer surfaces spiny, distal segment strong, with a bulged base carrying a strong accessory claw. Maxilla as usual in the genus. Basal segment of first maxilliped stout, distal segment slender, with two large distal inner spines and several spinules,

unguis with several well-spaced teeth along the border. Distal segment of second maxilliped strongly falcate, with distinct unguis.

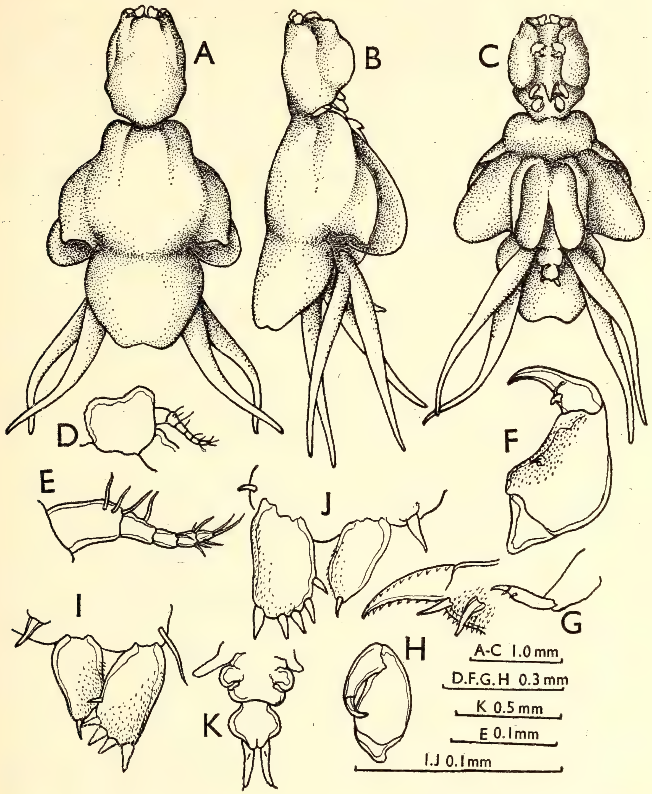

Fig. 8. *Lernanthropus alatus* sp. nov.: Female. A. dorsal view; B. lateral view; C. ventral view; D. first antenna; E. same, enlarged; F. second antenna; G. first maxilliped; H. second maxilliped; I. first leg; J. second leg; K. posterior division of trunk

First two pairs of legs subsimilar, basipod spiny, with slender outer seta and stout inner spine, exopod stout, with five dissimilar spines, endopod with a small apical spine, both rami spiny. Third leg biramous, exopods large and projecting outwards, endopods partially fused, with their outer border curled ventralwards. Fourth leg biramous, with long

subequal rami steadily narrowing towards the apex. Fifth leg vestigial, mere lobes just above the genital segment.

Total length 3.9 mm.

Remarks. In the general shape of the body *L. alatus* resembles *L. giganteus* but in the former the antero-lateral lobes of the carapace are less prominent, the lateral parts of the anterior division of the trunk are much expanded, the prominent triangular processes seen in *L. giganteus* are absent, the posterior border of the dorsal plate is bilobed and the third leg is biramous. In *L. alatus* the fourth pair of legs is longer than in *L. giganteus*. The peculiar modification of the basal segment of the first antenna is unique and easily distinguishes *L. alatus* from all the other species. There is also much difference in size between *L. giganteus* and *L. alatus*.

Lernanthropus carangis sp. nov.

Text-fig. 9

Material. 40 females were collected by the author from the gills of *Caranx sansun* (Forskal) at Trivandrum. Holotype, female, is deposited in the Indian Museum, Calcutta (Reg. No. C. 4441/1).

Female. Body very much like that of *L. alatus*. Carapace slightly longer than broad, with the antennal lobe narrow, one-third the total width, antero-lateral parts very prominent and projecting far beyond the antennal lobe, posterior half of lateral borders swollen, posterior border nearly straight. Anterior division of trunk enlarged, much broader than long, steadily broadening and terminating in a pair of prominent rounded lobes. Dorsal plate as long as anterior division of trunk but narrower, narrowing backwards, its posterior border with a median incision making it bilobed. Fifth trunk segment subequal to genital segment, abdomen roughly squarish. Anal laminae slightly longer than abdomen, with two long proximal setae and one outer and two apical spinules.

First antenna seven- to eight-segmented, with simple strong setae. Second antenna robust, basal segment with a spine-tipped papilla and distal segment with a claw. Maxilla with small inner lobe carrying one spine and large outer lobe with three spines, one of the spines very large. Basal segment of first maxilliped stout, distal segment with two spines, unguis with well spaced marginal teeth. Basal segment of second maxilliped with a spine-tipped papilla, distal segment with a strongly curved unguis.

Basipod of first leg with a pectinate inner spine, exopod stout and sparsely spiny, with five teeth, endopod internally spiny, with a terminal pectinate spine, longer than the ramus. Second leg with subequal rami,

basipod with outer spine. Third leg biramous, each ramus completely free and leaf-like. Fourth leg biramous, rami subequal, narrowing towards the apex and only slightly overreaching the posterior border of the dorsal plate. Fifth leg uniramous, less than half the length of fourth leg.

Total length 3.6 mm.

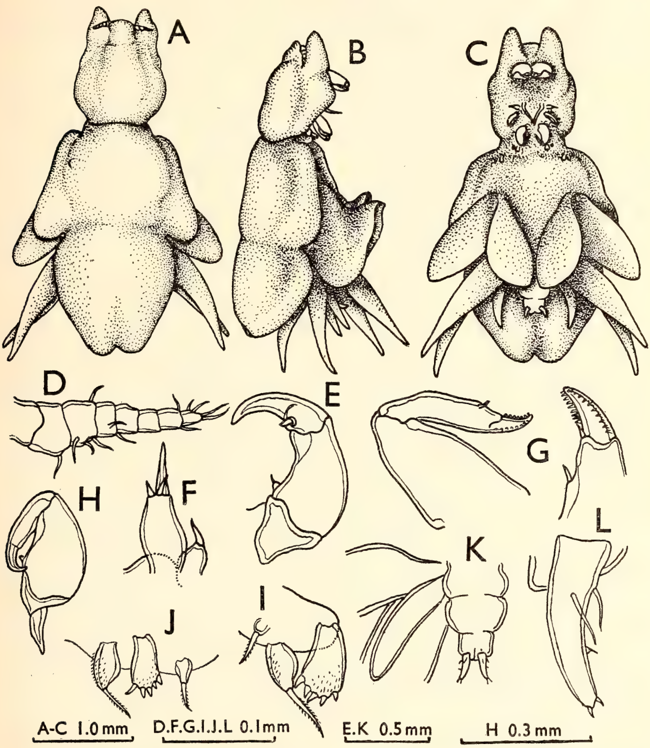

Fig. 9. *Lernanthropus carangis* sp. nov.: Female. A. dorsal view; B. lateral view; C. ventral view; D. first antenna; E. second antenna; F. maxilla; G. first maxilliped; H. second maxilliped; I. first leg; J. second leg; K. posterior division of body; L. anal lamina

R e m a r k s. In general shape this species resembles *L. giganteus* Kroyer and *L. alatus* Pillai. From the former it differs in the shape of the anterior division of the trunk and the postero-lateral processes of the trunk which are triangular in *L. giganteus* but rounded in *L. carangis*.

In *L. giganteus* the posterior border of the dorsal plate is straight. *L. carangis* resembles *L. alatus* to a greater extent but in the latter the shape of the postero-lateral processes of the anterior division of the trunk is different and the basal segment of the first antenna is very characteristic. *L. carangis* also resembles *L. eddiwarneri* Delamare-Deboutteville & Nunes-Ruivo (1954), but in the latter the third leg is different in shape and the dorsal plate overlaps the postero-lateral prolongations of the anterior part of the trunk. A remote resemblance to *L. priacanthi* Kirtisinghe (1956) is evident.

Lernanthropus robustus sp. nov.

Text-fig. 10

Material. 3 mature females, 1 immature female and 1 male were collected by the author from the gills of *Caranx* sp. at Trivandrum. Holotype, female, and allotype, male, are deposited in the Indian Museum, Calcutta (Reg. No. C. 4442/1). Allotype (Reg. No. C. 4443/1).

Female. Body stout and robust. Carapace roughly triangular in dorsal view, with the postero-lateral parts slightly produced, making the posterior border concave. Antennal lobe broad and convex, antero-lateral lobes prominent and blunt. Anterior part of trunk long and cylindrical, oblong in dorsal view. Dorsal plate demarcated from the anterior part of trunk by very deep lateral constrictions, steadily broadening backwards and as long as the latter, its posterior border concave, postero-lateral parts angular. Fifth trunk segment indistinct. Genital segment large. Abdomen longitudinally rectangular, about one and a half times as long as broad. Anal laminae as long as abdomen.

First antenna seven- to eight-segmented. Second antenna slender and long, basal segment with a proximal tubercle, distal segment with a greatly swollen base carrying a spine. Inner lobe of maxilla produced into a spine, outer lobe with three spines, one of them very large. Basal segment of first maxilliped very stout, distal segment slender, with a small bifid tooth and a long stout tooth, unguis with crenate border. Second maxilliped of moderate size, distal segment falcate, unguis not distinct.

Basipod of first leg with outer seta and inner spine, rami stout and spiny, exopod larger than endopod, with five teeth, endopod with long pectinate spine. Basipod of second leg with outer pectinate seta, exopod with four small teeth, endopod longer than exopod, with two long pectinate setae, both rami spiny. Third leg large and flattened, cut into four unequal lobes. Fourth leg biramous, rami narrowing towards the apex and not reaching beyond the dorsal plate. Fifth leg fusiform, half as long as fourth leg.

Total length 8.7 mm.

M a l e. Body distinctly demarcated into cephalothorax and trunk, former pyriform, with the antennal area indicated by lateral constrictions. Fifth and genital segments demarcated by lateral constrictions.

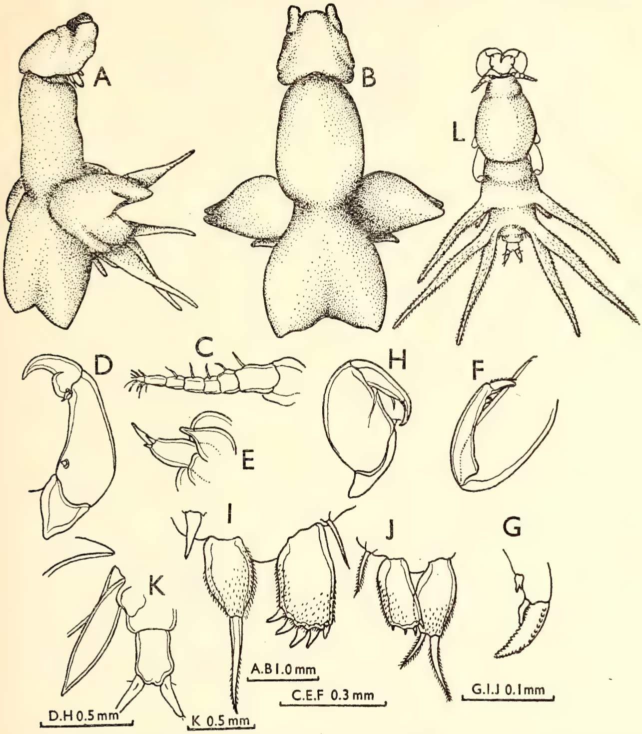

Fig. 10. *Lernanthropus robustus* sp. nov. : Female. A. lateral view ; B. dorsal view ; C. first antenna ; D. second antenna ; E. maxilla ; F. first maxilliped ; G. same, tip enlarged ; H. second maxilliped ; I. first leg ; J. second leg ; K. posterior division of body ; L. male

Abdomen very small, anal laminae longer than abdomen. Third leg biramous, exopod very long, endopod very short. Fourth leg biramous, both rami long, endopod slightly shorter than exopod, as long as exopod of third leg.

Total length 2.7 mm.

R e m a r k s. This species can be easily distinguished from all the others by its large size and the robust build ; it is one of the largest species, slightly larger than *L. giganteus*. The shape of the third leg and

the presence of two long spines on the endopod of the second leg also appear very diagnostic. *L. monodi* Delamare-Douboutteville & Nunes-Ruivo (1954) remotely resembles *L. robustus* in the cylindrical trunk and in the posteriorly bilobed dorsal plate. But these are the only characters they have in common.

Lernanthropus oblongus sp. nov.

Text-fig. 11

Material. 9 females and 2 males were collected by the author from the gills of *Sardinella fimbriata* (Val.) at Trivandrum. Holotype, female, and allotype, male, are deposited in the Indian Museum, Calcutta (Reg. No. C. 4444/1). Allotype (Reg. No. C. 4445/1).

Female. Carapace comparatively very small, oval, antennal area conical, reaching the level of the antero-lateral lobes, latter large and clearly folded ventralwards. Anterior part of trunk and the dorsal plate not separate, the two together forming a large oblong division, its antero-lateral parts produced into two forwardly directed triangular processes carrying a stiff setule on its outer border, posterior border perfectly rounded. Genital segment and abdomen small. Anal laminae as long as abdomen, with two proximal and two distal setae.

First antenna very small, seven-segmented, lateral parts of the ventral side of carapace, outer to the base of the first antenna, with a comb of spines. Second antenna comparatively small, inner part of first segment concave and tuberculated, second segment with two basal claws, one of them apically bifid. Maxilla with fairly broad lobes, outer lobe with three subsimilar spines. First segment of first maxilliped very stout, second segment small, with a spine and a few spinules at the distal inner border, unguis with serrate border. Second maxilliped very stout.

Basipod of first leg with outer and inner spines, exopod rather broad, with five barbed teeth, endopod with a short spine. Exopod of second leg with four teeth, endopod without spines. Third leg biramous, rami subequal and folded, their concavity facing each other. Fourth leg biramous, reaching far beyond the dorsal plate, endopod narrow, half as long as exopod, latter only slightly narrowing towards the apex. Fifth leg absent.

Total length 2.3 mm.

Male. Body demarcated into four divisions. Carapace large, broader than trunk, antennal area indicated by a slight constriction, second and third trunk segments fused, fourth larger than fifth, fifth fused with genital segment, carrying a pair of distally blunt back-

wardly directed processes, probably the fifth legs. Genital segment with a pair of flat processes. Abdomen very small, anal laminae spine-like.

Total length 1.2 mm.

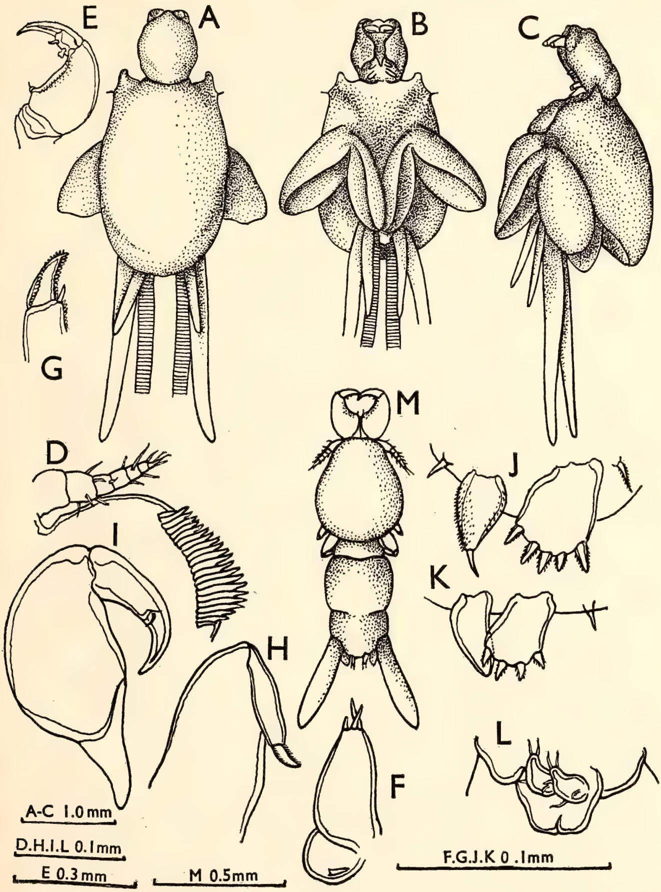

Fig. 11. *Lernanthropus oblongus* sp. nov. : Female. A. dorsal view; B. ventral view; C. lateral view; D. first antenna with spine row on carapace; E. second antenna; F. maxilla; G. tip of first maxilliped; H. first maxilliped; I. second maxilliped; J. first leg; K. second leg; L. abdomen and anal laminae; M. male

Remarks. The most distinguishing characters of this species are the row of spines on the carapace, the complete fusion of the trunk with the dorsal plate and the prominently dissimilar rami of the fourth leg. In general shape *L. oblongus* resembles *L. rubiginosus* Redkar, Rangnekar, & Murti (1949), but in the latter the antero-lateral processes of the trunk are different in shape. The posterior division of the body is described as twice the cephalon in length in *L. rubiginosus* but it is at least four times the length of the cephalon in *L. oblongus*. In *L. rubiginosus* the endopod of the fourth leg hardly overreaches the dorsal plate whereas it projects far beyond in *L. oblongus*. The male as illustrated by Redkar *et al.* is very different from that of the present species.

Lernanthropus opisthopteri sp. nov.

Text-fig. 12

Material. 2 females were collected by the author from the gills of *Opisthopterus tardoore* (Cuvier) at Trivandrum. Holotype, female, is deposited in the Indian Museum, Calcutta (Reg. No. C. 4446/1).

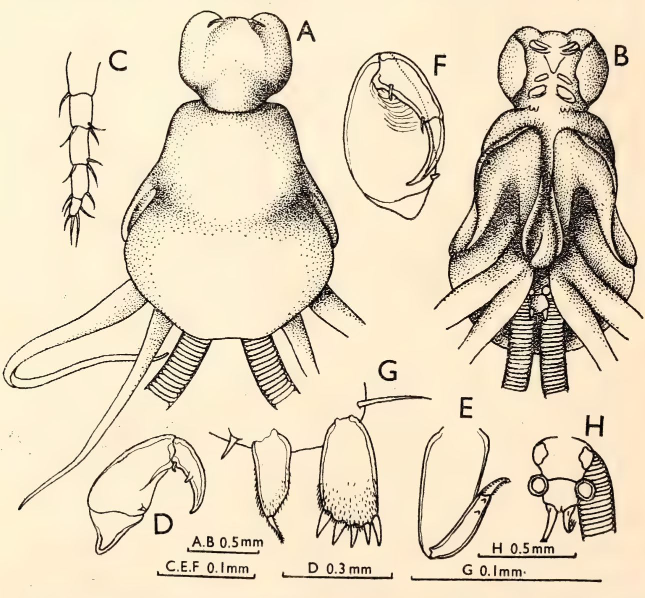

Fig. 12. *Lernanthropus opisthopteri* sp. nov.: Female. A. dorsal view; B. ventral view; C. first antenna; D. second antenna; E. first maxilliped; F. second maxilliped; G. first leg: H. posterior division of trunk

Female. Body demarcated into carapace, trunk, and dorsal plate. Carapace semicircular, anterior border trilobed, antennal lobe low, antero-lateral parts highly expanded and broadly rounded, reaching beyond the antennal lobe, posterior part of carapace abruptly narrowed, posterior border convex, overlapping the trunk. Anterior division of trunk broader than long, slightly longer than carapace. Dorsal plate very broad, as long as anterior division of trunk, narrowing backwards, posterior border short and slightly sinuous. Genital segment longer than abdomen, abdomen as long as broad, anal laminae slender, longer than abdomen, with one proximal and four apical setules.

First antenna five-segmented. Second antenna stout, first segment with one and second with two claws. Maxilla as usual in the genus. First segment of first maxilliped stout, second slender, with two small teeth, unguis with spiny border. First segment of second maxilliped stout, with a proximal spine, second segment as long as basal, with two spines, unguis long and strongly curved.

First and second legs subsimilar, basipod with a long outer seta and short inner spine, exopod stout, with five rather long sharp teeth, endopod with a short pectinate spine, both rami sparsely spiny. Third leg with the rami fused and folded, directed forwards, with the concavity facing downwards, the two endopodal lobes distally free and directed backwards. Fourth leg biramous, rami very long and slender, exopod about one and a half times as long as endopod. Fifth leg absent.

Total length 2.1 mm.

Remarks. In the general shape of the body this species is nearest to *L. atrox* Heller (1865) as described by Shiino (1955), but the extremely long and slender fourth leg easily distinguishes it.

Lernanthropus gibbosus sp. nov.

Text-fig. 13

Material. 12 females and 1 male were collected by the author from the gills of *Saurida tumbil* (Bloch) at Trivandrum. Holotype, female, and allotype, male, are deposited in the Indian Museum, Calcutta (Reg. No. C. 4447/1). Allotype (Reg. No. C. 4448/1).

Female. Body stout and rather deep. Carapace longer than broad, with a very broad, subtruncate antennal area, lateral parts forming large lobes bent downwards and projecting beyond the antennal lobe as conical projections in dorsal view and appearing as oblong lobes in lateral view. Postero-lateral parts of carapace bulged and postero-median part forming a high boss. Anterior division of trunk

longer than broad, with a pair of antero-lateral and a single antero-median boss, demarcated from the dorsal plate by very shallow lateral grooves. Dorsal plate longer than anterior division of trunk,

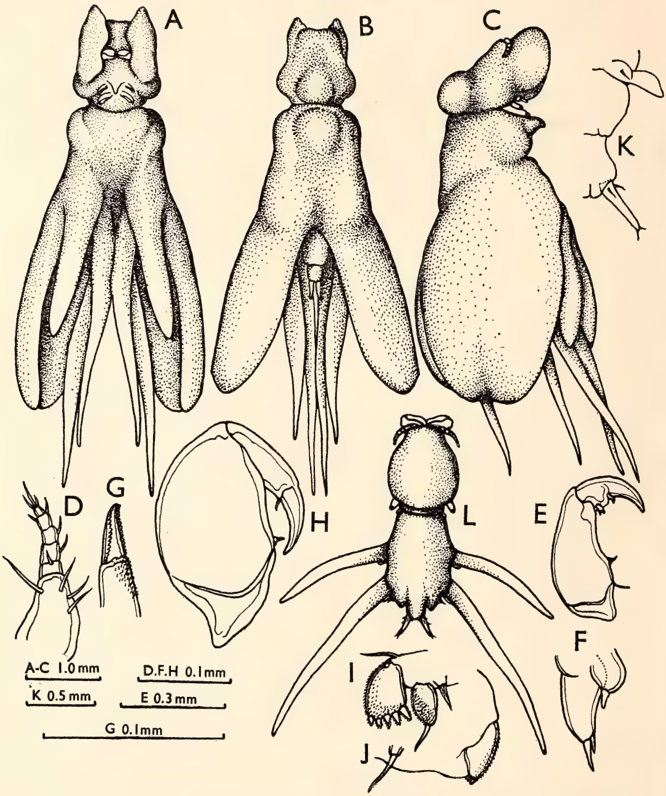

Fig. 13. *Lernanthropus gibbosus* sp. nov. : Female. A. ventral view ; B. dorsal view ; C. lateral view ; D. first antenna ; E. second antenna ; F. maxilla ; G. tip of first maxilliped ; H. second maxilliped ; I. first leg : J. second leg ; K. posterior division of trunk ; L. male

forked right up to its base, leaving the genital segment and abdomen fully exposed, each half of the dorsal plate displaced towards the lateral side, with its ventral part folded downwards. Genital segment and abdomen subequal in length, the former broader. Anal laminae as long as abdomen, with two proximal and two distal setae.

First antenna six-segmented, first segment very large. Second antenna stout and strong, basal segment with a spine-tipped papilla, distal segment with two claws, proximal claw bifid. Maxilla two-lobed, inner lobe with one and outer with two spines. Distal inner part of second segment of first maxilliped spiny, unguis with blunt teeth along the borders. Second maxilliped with very stout basal segment, distal segment strongly falcate.

Basipod of first leg with outer seta and inner spine, exopod with five barbed teeth, endopod with a long spine, both rami strongly spiny. Second leg vestigial, exopod with three or four small teeth, basipod carrying a small lobe with a long spine, endopod absent. Third leg uniramous, slender and long. Fourth leg biramous, overreaching the dorsal plate, exopod longer. Fifth leg present but much degenerated.

Total length 6.1 mm.

Male. Carapace pyriform, anteriorly narrowed to form the antennal lobe. Trunk oblong, with a distinct segment demarcated anteriorly. Abdomen distinct, anal laminae longer than abdomen. Third leg long, biramous, exopod long, narrowing towards the apex, endopod represented by a small lobe. Fourth leg similar to third but the exopod twice as long as that of third. Fifth leg represented by two spine-tipped papillae.

Total length 1.6 mm.

Remarks. In the deeply forked dorsal plate *L. gibbosus* resembles *L. trachuri* Brian (1906) and *L. forficatus* Redkar *et al.* (1949). In *L. trachuri* the third pair of legs are fused but completely free in *L. gibbosus.* The strongly gibbose carapace and anterior division of trunk distinguish the present species.

Lernanthropus decapteri sp. nov.

Text-fig. 14

Material. 69 females were collected from the gills of *Decapterus russelli* (Ruppell) by the author at Trivandrum. Holotype, female, is deposited in the Indian Museum, Calcutta (Reg. No. C. 4449/1).

Female. General shape like that of *L. trachuri* Brian (1906). Carapace nearly equal in length and breadth, antennal lobe indistinct, antero-lateral lobes of carapace prominent and projecting far beyond the antennal lobe, posterior part constricted. Anterior division of trunk equal in length and breadth, antero-lateral parts shoulder-like, very slightly expanded. Dorsal plate slightly longer than anterior division of trunk, almost a continuation of the latter, deeply forked, each limb

of the fork oblong. Fifth segment short, genital segment squarish, abdomen as long as broad, distally bulged just above the insertion of the anal laminae. Anal laminae very small, conical.

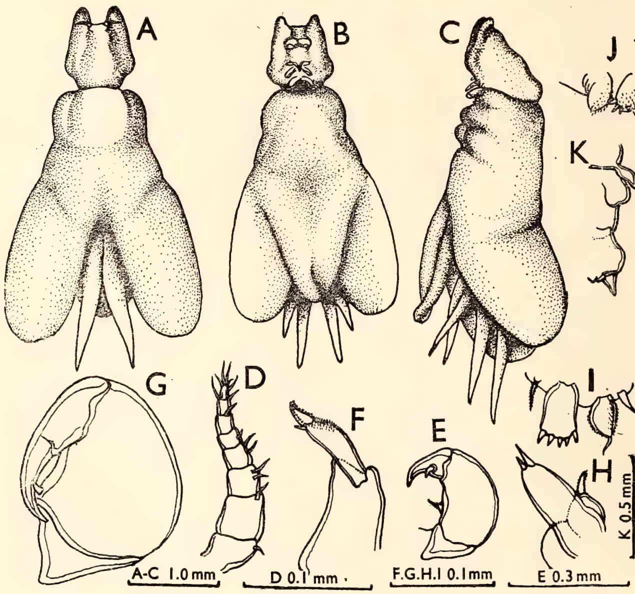

Fig. 14. *Lernanthropus decapteri* sp. nov.: Female. A. dorsal view; B. ventral view; C. lateral view; D. first antenna; E. second antenna; F. first maxilliped; G. second maxilliped; H. maxilla; I. first leg; J. second leg; K. posterior division of trunk

First antenna eight-segmented. Second antenna stout, basal segment with a spine-tipped papilla, distal segment stout, with a strong claw. Inner lobe of maxilla with a pectinate spine, outer lobe large, with two small spines. Basal segment of first maxilliped stout, distal part of distal segment with one spine and several spinules, unguis with serrate border. Second maxilliped very strong, basal segment nearly equal in length and breadth, distal segment as long as basal, with very long unguis.

First leg as usual in the genus, endopod of second leg lacking the spine. Third leg uniramous, the two members fused, except at the tip, forming a backwardly directed conical lobe stopping a little short of the tip of the dorsal plate. Fourth leg biramous, exopod longer

than endopod and overreaching the tip of the dorsal plate. Fifth leg vestigial.

Total length 3.4 mm.

Remarks. This species has the closest resemblance to *L. forficatus* Redkar *et al.* (1949), but differs in the more robust body and the shorter fourth pair of legs. The description of *L. forficatus* is such that a more detailed comparison is not possible.

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On the food and other habits of the Greater Flamingo (*Phoenicopterus roseus* Pallas) in India

BY

HUMAYUN ABDULALI

(*With two plates*)

Notes on the food and other habits of the Greater Flamingo (*Phoenicopterus roseus* Pallas), an otherwise well-known bird in India, are so scattered and incomplete that I am prompted to offer a summary of the records available to me, together with a few personal notes and observations.

FOOD

Blanford (1898) stated that the food consists 'according to most authors partly of small crustaceans, worms and insects, with larvae and ova, partly of vegetable matter ; but Gadow says, essentially of organic slime, confervae (algae) and etc.' Stuart Baker (1908) says : 'they are also in all probability far more given to animal food than is generally believed to be the case'. Later (1929) he made the general statement : 'much of the food is of a vegetable nature, but they also eat tiny water insects, crustacea, and mollusca, while in the south of France they feed entirely on a tiny brine shrimp *Artemia salina*'.

Ticehurst (1923) noted Greater Flamingos feeding on small mullet fry in pools left by spring tides at Karachi and also referred to seeds of the Common Lucerne (*Medicago lupulina*) and a sedge (*Cyperus* sp.) found in the gullet of another—these, he thought, were washed down by flood water from cultivation a mile or two off.

In September/October 1935, McCann (1940) visited the only breeding colony in India, in the Great Rann of Kutch, to collect specimens for the natural habitat group in the Prince of Wales Museum of Western India, Bombay. 7 adults and 8 chicks were collected and he recorded that the stomachs of the chicks held a quantity of sand which contained 'nothing except a collection of small black seeds' which he later identified as of *Ruppia rostellata.* The adult stomachs contained some of the same seeds, some brown seeds, and some portions of aquatic plants resembling *Naias* and *Chara.* The brown seeds were identified as

Greater Flamingos (*Phoenicopterus roseus*) in East Africa

1. A breeding colony

2. Territorial display

Photos : Leslie Brown

Lesser Flamingos (*Phoeniconaias minor*) in East Africa

1. Flamingos watering at Lake Hannington

2. A breeding colony

Photos : Leslie Brown

those of the sedge *Scirpus maritimus*, which occurs in the marshes not far from Khavda in Kutch.

McCann further noted that he could find no trace of any living matter on the ground or in the water near the nesting colony and suggested that, *Ruppia* being unable to stand salt water, the presence of a sufficient number of seeds was only possible if it grew rapidly when the Rann was first inundated with fresh water from the eastern streams and seeded before the sea-water flowed in and the salinity increased with dessication.

Ruppia maritima is known as widgeon grass in America and is recommended as a duck food plant in areas with a salinity of 10,000 p.p.m., or more. Duck eat the seeds, leaves, stems, and roots of this plant (Saline Soils & Brackish Waters in Management of Wild Life, Fish & Shrimp. Trans. 27th N. American Wild Life Conference, pp. 321-335. Not seen in original).

Sálim Ali (1945) in ' More about the Flamingo in Kutch ' referred to McCann's records and commented that plant seeds could not form the staple diet of the flamingo in these parts as they were unlikely to be washed down into the Rann in sufficient quantity. He did not say anything about McCann's suggestion that the *Ruppia* seeds come from plants grown *in situ* during the initial period of flooding by river water. He shot two adults in the salt pans of Kandla in September and found in them coarse sand, a small quantity of slimy greenish brown vegetable matter, and over 50 red thread-like *Chironomus* larvae (*c.* 10 mm. long).

S. A. Akhtar of Kabul (1947) reported a visit to a salt lake at Ab-Istadeh in the Afghan mountains where they collected a lot of flamingo eggs and examined the stomach of one bird which was found to contain clay and sand, 3 water beetles, 10 back-swimmers, 23 midge larvae, and most abundantly the remains of black ants ! More recently Mr. M. W. Ridley (1954) referred to the food preferences and the feeding habits of the Greater (*Phoenicopterus roseus*) and the Lesser (*Phoeniconaias minor*) Flamingos in East Africa. He drew attention to the fact that the Lesser Flamingo does not submerge its bill but merely skims the surface of water while the larger bird generally but not invariably submerges its head in water while feeding.

Ridley examined about 40 stomachs and found blue-green algae (Myxophyceae) and Diatoms (*Navicula* and Bacillariophyceae) to be the major food of the Lesser Flamingo, while the larger one contained a great variety of foods, animal as well as vegetable. The former consisted largely of Chironomid larvae, Corixids (water boatmen), Copepods, various insect larvae, while the latter included sedge seeds, algae and diatoms, remains of leaves of higher plants. In addition to the records from India already quoted, he refers to Gallet's suggestion that they feed on the organic content of the mud and quotes Chapman to

the effect that the American subspecies feeds largely on the marine snail *Cerithium* and the old world race, according to Lord W. Percy, on a similar mollusc in the Red Sea.

On the 4th August 1963, I shot a Lesser Flamingo feeding busily in shallow puddles left by the receding tide at Salaya in the Gulf of Kutch. The crop was closely packed with algae and Prof. (Mrs.) E. Gonsalves of St. Xavier's College, who very kindly examined the material, reports: ' It consists almost wholly of blue-green algae. Diatoms are extremely rare. Grit and sand particles occur in small amount, along with what appears to be a mucilaginous substance.

' The filaments of the blue-green algae are broken into short and long lengths. The most conspicuous form present is a species of *Oscillatoria* —*Oscillatoria princeps* Vaucher. The filaments are very slightly narrower than those of the type (14.5μ to 17.1μ in diameter) but in other respects resemble it. The fragments varied in length from 20.3μ to 617.5μ (=0.02 to 6.175 mm.). *Oscillatoria tambi* (Woronichin) is present in fair quantities, as also *Oscillatoria nigro-viridis* (Thwaites) to a lesser extent. A small species of *Lyngbya* is also included. Diatoms ranging in dimensions from 21-51 μ length and 6-10.5 μ breadth are occasionally seen.'

Allen (1956) has translations from THE BIRDS OF THE SOVIET UNION by Dementiev, in which doubt is cast on an earlier statement by Henke (1882) that flamingos feed their fledglings with small frogs procured in freshwater lakes. Mesbar (quoted by Allen, loc. cit.) stated that flamingos feed on small molluscs, while he is also said to have held that a unicellular water-plant, *Aphanothece*, plays a considerable part in the nourishment of flamingos. These red-coloured plants, floating in the water and exhaling a strong stench, are deposited in small still sea-bays where they are eaten by the birds. This is said to have been later confirmed by Issakot in 1948 on the eastern shore of the Caspian Sea. Seven stomachs of the flamingos contained this water plant in considerable quantity and in every one of 6 stomachs the seeds of *Ruppia maritima* were also found, forming more than one half of the entire stomach content in volume. Importance is also given to their feeding on molluscs, mainly small cockles, and Issakot is quoted as saying that the winter food consists mainly of crustaceans and small molluscs. It is further added that *Artemia salina* and its roe were an important part of flamingo food in northern Iran in the past, but because of the increasing salinity in the water of the Karabogaz Bay this crustacean has now disappeared completely.

D. B. Carlisle, Anti-Locust Research Centre, London (1962), affirms that ' the pink plumage of the flamingo is the result of diet and the pigment is taken almost unchanged from the small shrimp-like creature which forms a large part of the food. This red pigment is then

deposited in the feathers where it slowly fades in the sunlight. To maintain the pink plumage, therefore, the flamingo needs constant access to food rich in pigment (which it cannot make for itself), and a diet poor in carotenoids, as these pigments are called, may produce a flamingo with white plumage '.

Among the vertebrates, according to Allen (loc. cit.), Wilughby (1678) said that flamingos eat fish but there is only rare confirmation of this statement. Bryant (per Allen, loc. cit.) stated in 1866 that he had found small fish in flamingos he had collected in Inagua (Bahamas) and these were identified as *Cyprinodon* sp., probably *variegatus*.

Sálim Ali and I visited the Rann in April 1957 and found evidence of a plentiful supply of *Cyprinodon dispar* between 2 and 3 inches in length. In April 1960, P. W. Soman on a visit to the flamingo-pelican colony saw lumps of freshly caught fish of this species fed to and disgorged by young pelicans. Earlier in the season it is quite possible that the area contains sufficient numbers of small fry to feed the flamingos.

In July 1962, Br. Navarro sent to the Bombay Natural History Society the stomach of a flamingo shot at Bhyandar, Salsette, Bombay. D. N. Mathew, Research Assistant of the Society, has sorted out the contents and reports :

(*a*) *c.* 1100 small black seeds identified as of *Ruppia maritima*, and

(*b*) *c.* 15,000 small brown seeds identified as graminaceous, both identified by Prof. Bole of St. Xavier's College, and

(*c*) *c.* 300 pieces of small grit and mud, and

(*d*) *c.* 1000 Chironomid larvae.

Gallet (1950), Jenkins (1956-57), and Brown (1959) revive the theory that flamingos feed on the mud which is rich ' in organic bacterial material ' (Zahl 1953). ' Mud ' is no doubt found in flamingo stomachs and Gallet (loc. cit.) states that the mud in which the birds were feeding had an organic content of 6% to 8%. In my opinion the statement that flamingos eat and live on mud is only true in the sense that mud containing organic material which can be assimilated in the flamingo's stomach is taken in. The mud does not undergo any chemical change, and is no doubt passed out again as mud.

The highly specialised bills permit separation of tiny forms of animal life which may not always be visible to the human eye. I found a large number of shell pieces consisting mainly of the central screw of a snail-shell in such mud. While these may have been swallowed in this form with the mud, they appeared to be sufficiently abundant to suggest that live shells were swallowed and ground up in the stomach. Allen (1957 : 24) writing of the Bahamas said that the salinity in the lakes limited the number of species that existed in such environments but did not necessarily limit their numbers. ' Certain microscopic

organisms—diatoms, dinoflagellates, rhizopods, bacteria of several kinds, nematode worms, immature molluscs and other forms may be astonishingly abundant'. He added that *Cyprinodon variegatus* was omnipresent.

Habits

When Sálim Ali and I attempted to visit a reported breeding colony in the Rann near Banjda Bhet, various circumstances prevented our reaching the colony. However, off the eastern shore of Pachham we saw groups of 12 to 30 young being shepherded in columns by an approximately equal number of adults over the dry mud in a south-westerly direction towards a large congregation of flamingos in the water in the distance, some 15 miles away from the nesting site. When a marching party was approached, a number of adults first flew off with a loud goose-like gaggle. The remaining adults were strung out in line covering the young with their outstretched wings. As excitement increased, the wings were rapidly vibrated, mostly above their backs and without being brought much below the horizontal. Their wings formed an umbrella over the young which were of markedly different sizes (12-14 to 24 in.) and the gaggling and the wing-waving appeared to be to get them to move along more quickly. When approached to within 50 yards, the adults flew low over the young for some distance before leaving them to continue in the original direction, but now as a scattered and broken flock. We observed some 6 parties in the two hours that we were in the neighbourhood. Parties of adults were seen flying northwards from the congregation towards the nesting site but settling too far away to determine if this was in the neighbourhood of more young.

A chick was accidentally killed. This was quickly and gladly appropriated by our attendants who said that some of the neighbouring villagers killed a large number of flightless young for food.

At Sadhara, a little to the south and nearer the congregation of flamingos, the water was far away but the shore was formed of almost dry grey mud over which it was possible to drive a jeep without difficulty. At the edges there were washed-up quantities of vegetation (*Ruppia* sp. ?) in large sheets, several square feet of which could be lifted up at a time. Underneath, it was still damp and there was a considerable insect fauna.

On the southern edge of the Rann (northern edge of Pachham Island) large areas were heavily encrusted with salt and the masses of vegetation seen washed up along the Sadhara shores were not noticed. Several of the small rivulets and parts of the shore were most prominently encrusted with salt which appeared to be thickest in the narrower bays,

often forming pinnacles an inch high. Northwards into the Rann, many fish were seen embedded on the surface of thick layers of salt. Their number appeared to be more and more numerous further eastwards, this being particularly prominent along the edges of rock pools and other inlet bays. Some of these pools still held water, but masses of fish were already encrusted in the salt eight or ten inches above the surface, evidencing the fact that the salinity had become too great for their existence when the water was much higher. In places, dry fish could be scooped up in handfuls. The fish were mostly about 3″ in length and were present in lumps and heaps. As our horses marched through the larger stretches of water, fish in distress were seen over a great area. In a few days the fish which now existed in such enormous numbers would all be dead and embedded in the salt. Specimens have all been identified by the Director of Fisheries, Bombay, as *Cyprinodon dispar*, a fish known to occur in East Africa, but not recorded from Indian waters since Day referred to two specimens from Kutch in his FAUNA (1878). Water in the pools drying up near the shore showed a purplish tinge. Of course no live fish were seen in any of these pools.

Portions of the Rann on the north and east of Pachham were drying up and some areas bore the footprints of an inconceivable number of pelicans and many other birds, indicating a concentration of food (probably fish) which had brought them together some time earlier.

These areas were indiscriminately mixed with the feeding mounds of the flamingos which do not appear to have been referred to in Indian literature. They consisted of circular trenches 6 inches wide, 2 or 3 inches deep, and 3 or 4 feet in diameter. The centre was slightly raised and these dry rings were quite close to each other over large areas and superficially suggestive of their nesting colonies. The central mounds showed no sign of the flamingos having stood thereon. We did not see any birds feeding in these rings but this has been described by Gallet (loc. cit.) in the Camargue. The circular trench is formed by the flamingo moving backwards, trampling and stamping with its feet and producing the liquid-mud conditions in which its bill sorts out the sand from the mud, the former making the mound in the centre, and the latter, presumably now holding more than 6-8% organic material, being swallowed (see above).

McCann (loc. cit.) reported that, when the colony was reached a week after the first report, the nests which had been standing in water were quite dry and the large assemblage of chicks were in water 3 miles away. At the nest site, water was 4 feet below the surface. He also noted that the four adults collected with the young were all males.

Brown (1959) who has considerable experience of both species in Africa has stated that the young are fed by their parents by regurgitation. The first day or two of life is spent with the parents on the nest and they are fed on some fluid disgorged by the parents. After two or three days the chicks became active and moved about the island. They swam freely when about 12 days old and formed bands of several hundreds together. Huge flotillas of young were in charge of the few adults who acted as 'aunties'. When they first took to water, these aunties were in the ratio of one to ten—later one to several hundred chicks. They were fed by parents from about 5.30 p.m. onwards and Brown thought that each parent recognised its young and fed it. He has also interesting notes and suggestions regarding the wing salute in courtship, as also the moult of their wing-feathers. In India we know very little about these matters and, in the absence of any evidence in the other direction, it is generally accepted that the young find their food in their surroundings. Gallet (loc. cit.) refers to some liquid drops being fed to the young, but goes on to say that this cannot form the bulk of their food, which according to him is obtained from the mud. The single chick which I had the opportunity of examining contained a few seeds !

If the food is not present in the water near the nests, the young are marched to the food-grounds which may be 15 miles or more away. In keeping with the rapidly changing level of the water and its salinity, it is not unlikely that some forms of food, including perhaps the shrimp, *Artemia salina*, are periodically and locally abundant. There is evidence of such periodic abundance in the fish *Cyprinodon dispar*.

In India we have no information regarding the flamingo moulting all its wing quills at one time, though there is a little evidence of this taking place in both resident and migrant duck. Brown (1959), quotes Swynnerton as stating that the adults became flightless when they had young and are captured by natives as food, while Allen (1959 : 149) states that, in the Bahamas, they become flightless in September when the young are just learning to fly by their own efforts. He also says that the great flocks quit the nesting lakes when the young are able to fend for themselves, leaving the remaining food supply to their growing offspring.

General

There is room for much interesting field work to be done to clear up the many queries. Many incidental and other problems will arise in the restricted ecological unit of the Rann, and further trips must be undertaken by a team of workers prepared to live near the birds for some time.

The Rann is a large area over which vehicular traffic is not possible. The completion of arrangements for the final trip into the Rann was in itself a tiring matter. In our own instance, we picked up a jeep at Bhuj and were scheduled to meet Jamal and his camels at Sharda on the eastern shores of Pachham Island. We arrived there to discover that the approach was to be made from the northern edge which could only be reached by driving right round the island. This took several hours, after which we had to wait for the camels to arrive. The first half-hour on camel-back inclined one to give up the trip and to stagger back to camp. As the animals slithered through the mud, there was little opportunity or urge to stop and examine the muddy bottom for tiny forms of plant or animal life. The guide and other attendants were only interested in reaching a specified place whence the birds were visible. Once the birds were seen, they showed no further interest in our attempts at closer observation and were then only concerned with stressing the fact that it was necessary to turn back soon. For further and detailed studies, it would be necessary to camp for longer periods nearer the colony and for several people to work together, so that studies can be continued uninterrupted over rapidly changing conditions. Here is a Natural History problem of great interest almost before us. Will some young enthusiasts take it up and fill in the many gaps in our knowledge?

Acknowledgements

I am grateful to Mr. Leslie Brown for his remarks on my preliminary draft and for the excellent photographs which accompany this note. I am also grateful to Mr. D. E. Reuben for the patience with which he has read the several drafts and discussed changes therein.

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Algal Flora of Jodhpur and its Environs

II. Cyanophyta

BY

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[*Continued from Vol.* **59** (2) : 452]

(*With three plates*)

The present series deals with the systematic account of the Blue-Green algal flora of Jodhpur and its environs.

Systematic Enumeration

1. **Microcystis aeruginosa** Kütz. Geitler in Rabenhorsts, Kryptogamenflora **14** : 137, f. 59d, 1932 ; Desikachary, Cyanophyta, p. 93, t. 17, f. 1, 2, 6, et t. 18, f. 10, 1959.

Colonies floating, solid when young, becoming clathrate in old stage ; cells spherical, 3.8-5.7 μ in diameter.

Habitat : From Lalsagar near Jodhpur (9-8-59).

2. **Chroococcus turgidus** var. **maximus** Naygaard. Geitler 228, f. 109b, 110, 1932.

Cells spherical or ellipsoid, in groups of 2-4, 6.7-26.6 (-38.0) μ broad, (7.6) 13.3-15.2 μ long ; sheath colourless, distinctly lamellate (Plate I, fig. 5).

Habitat : Along with *Aphanothece pallida* (Kütz.) Rabenh.

3. **Aphanothece pallida** (Kütz.) Rabenh. Geitler 171, f. 78, 1932.

Thallus gelatinous forming big cylindrical floating masses, pale yellow, 3-4 inches in diameter ; cells sub-spherical to oblong, with sheath 7.6-9.5 μ broad, 9.5-11.4 μ long ; without sheath 5.7-7.6 μ broad, 7.6-9.5 μ long ; sheath distinct and lamellate (Plate I, fig. 2).

Habitat : Free floating in Takhatsagar near Jodhpur (10-11-1959).

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4. **Synechococcus elongatus** Nāg. Geitler 273, f. 133a-c, 1932.
Cells cylindrical, 1.9-2.8 μ broad, 3.5-4.0 μ long (Plate I, fig. 1).
Habitat: Along with *Chlorococcum* sp.

5. **Synechocystis aquatilis** Sauv. Geitler 270, 1932.
Cells spherical, 2-4 together, 5.7-7.6 μ in diameter (Plate I, fig. 3).
Habitat : From Lalsagar near Jodhpur (10-8-59).

6. **Arthrospira platensis** var. **tenuis** (Rao) Desikachary 190, t. 35, ff. 4, 11, 1959.

Plant mass blue-green, trichomes with uniform width, 5.7-7.6 μ broad, in regular spirals, spirals away from each other, 36.1-38.0 μ broad, 45.6-49. 4 μ distant ; not constricted at cross walls ; end cell rounded (Plate I, figs. 6, 7).

Habitat : From Lalsagar near Jodhpur (9-8-1959).

7. **Oscillatoria obscura** Brühl et Biswas in J. Dept. Sc. Calcutta Univ. **4** : 6, t. 2, f. 9. 1922.

Trichomes pale brown, not constricted at the joints ; cells 5.7-7.6 μ broad, 2.8-3.8 μ long, cross walls granulate ; gas vacuoles absent ; apex obtuse and slightly bent (Plate III, fig. 22).

Habitat : Along with *Arthrospira platensis* var. *tenuis* (Rao) Desikachary.

8. **Oscillatoria princeps** Vaucher ex Gomont. Geitler 947, f. 598b, 601c-g, 1932.

Trichomes dark blue-green forming aegagropilous balls in fresh water ; trichomes not constricted at the cross-wall regions, 38.0-45.6 μ broad, 3.0-4.0 μ long ; apical cell flatly rounded without thickened membrane (Plate I, figs. 9, 10).

Habitat : From a pond near Kaylana (10-9-59) and from a *baori* (=well) at Mandore (15-9-59).

9. **Lyngbya aerugineo-coerulea** (Kütz.) Gomont. Geitler 1062, f. 670, 1932.

Filaments solitary, sheath thin, 9.5-11.4 μ broad, not constricted at the cross-wall regions ; cells 7.6-9.5 μ broad and 3.8-5.7 μ long (Plate I, fig. 8).

Habitat : Attached to submerged rocks at Kaylana (10-9-59).

10. **Lyngbya subtilis** West. Geitler 104b, 1932.

Filaments solitary, free floating, up to 1.9 μ in diameter; sheath close, hyaline ; cells 0.9-1.8 μ long.

Habitat : From Kaylana near Jodhpur (10-9-59).

11. **Lyngbya constricta** Fritsch et Rich. in Trans. Roy. Soc. South Afr. **18** : 83, f. 29A-C, 1929.

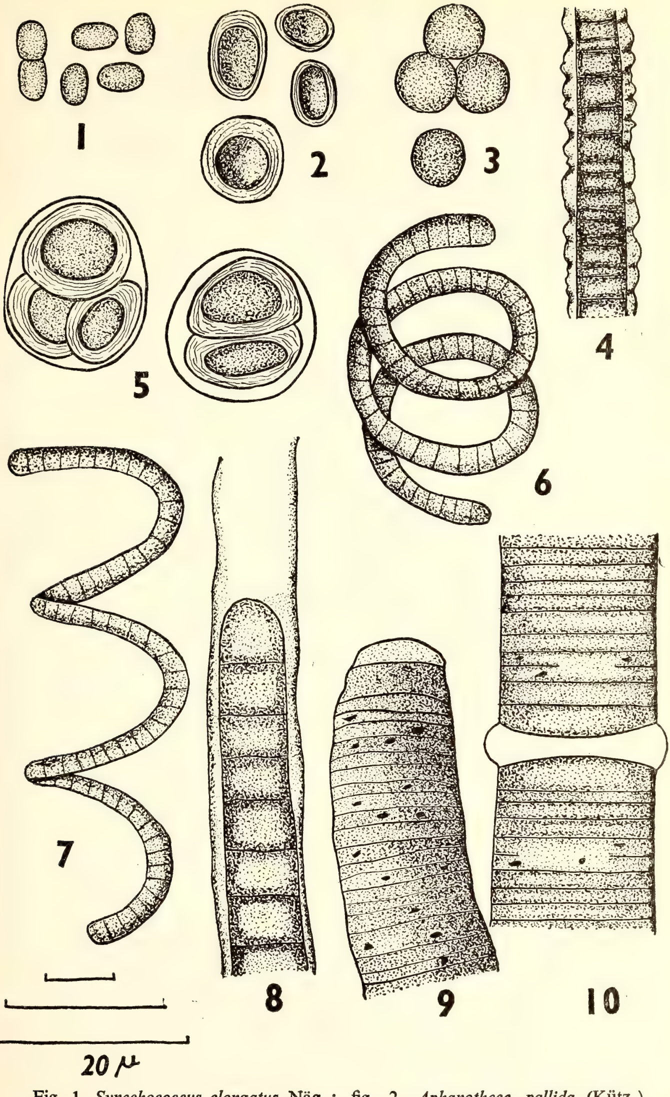
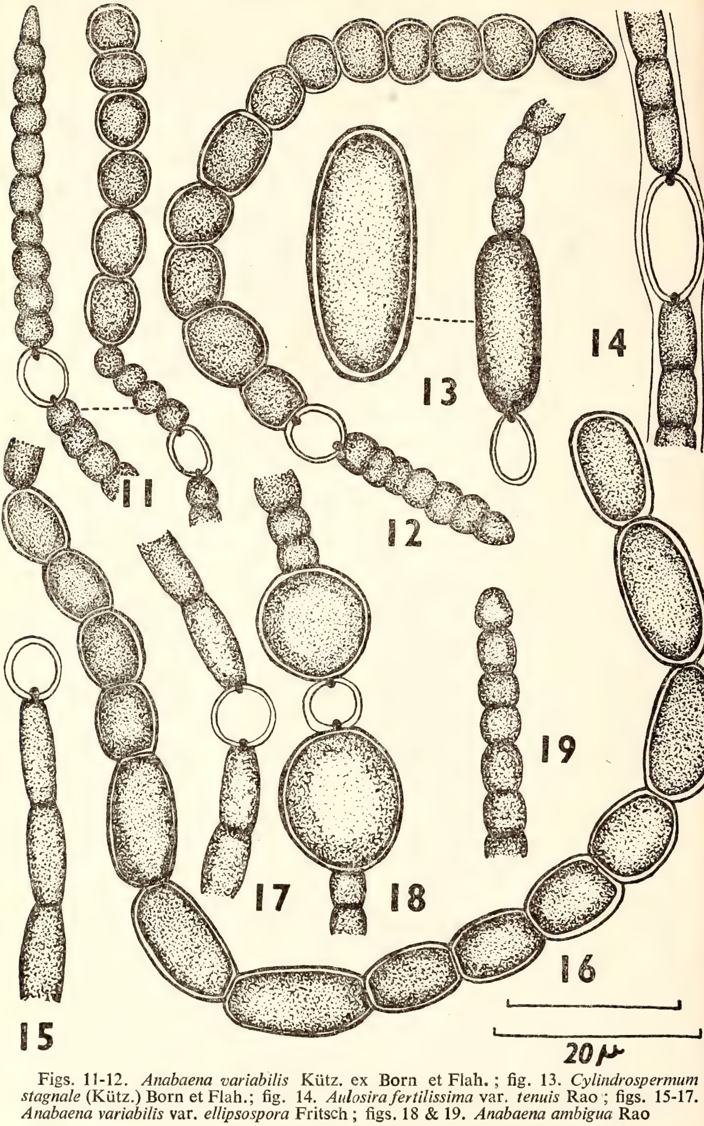


Fig. 1. *Synechococcus elongatus* Näg.; fig. 2. *Aphanothece pallida* (Kütz.) Rabenh.; fig. 3. *Synechocystis aquatilis* Sauv.; fig. 4. *Lyngbya constricta* Fritsch et Rich.; fig. 5. *Chroococcus turgidus* var. *maximus* Naygaard; figs. 6 & 7. *Arthrospira platensis* var. *tenuis* (Rao) Desikachary; fig. 8. *Lyngbya aerugineo-coerulea* (Kütz.) Gomont; figs. 9 & 10. *Oscillatoria princeps* Vaucher ex Gomont



Figs. 11-12. *Anabaena variabilis* Kütz. ex Born et Flah. ; fig. 13. *Cylindrospermum stagnale* (Kütz.) Born et Flah.; fig. 14. *Aulosira fertilissima* var. *tenuis* Rao ; figs. 15-17. *Anabaena variabilis* var. *ellipsospora* Fritsch ; figs. 18 & 19. *Anabaena ambigua* Rao

Thallus brownish green, epiphytic on submerged plant parts ; filaments smooth ; cross-wall regions not constricted ; cells shorter than broad ; sheath colourless, constricted (Plate I, fig. 4).

Habitat: Along with *Lyngbya subtilis* West from Kaylana near Jodhpur (10-9-59).

12. **Cylindrospermum stagnale** (Kütz.) Born et Flah. Geitler 819, f. 520 ; 1932.

Thallus delicate, floating, greyish ; trichomes 3.8-5.7 μ broad, constricted at the cross-walls ; cell as long as broad or slightly longer, 3.8 μ broad, 3.8-5.7 μ long ; heterocysts subspherical or oblong, 13.3-15.2 μ long and 9.5-11.4 μ broad ; spores cylindrical with rounded ends, (11.4) 22.8-30.4 μ long, (7.6) 9.5-12.0 μ broad, with smooth yellowish outer layer (Plate II, fig. 13).

Habitat: In stagnant water near Motikund, Jodhpur (19-5-59).

13. **Wollea bharadwajae** Singh in Ann. Bot. Lond. n. s. **6** : 593-606, 1942.

Thallus tubular with finger-like projections, attached 2-3 cm. long and 2-3 mm. broad ; trichomes parallel ; tapering towards the apex, constricted at the cross-walls ; cells barrel-shaped, 3.5-5.7 μ broad, 2.5-3.8 μ long, apical cell conical ; heterocysts intercalary, 3.8.-5.7 μ broad, 3.8.-5.7 μ long ; spores spherical or subspherical forming singly or in pairs on either side of the heterocysts, 7.6-9.5 μ broad, 7.6-11.4 μ long (Plate III, figs. 21, 26).

Habitat: From a tank near Akhey Raj Ji's Bungalow, Jodhpur (10-9-59).

14. **Anabaena ambigua** Rao in Proc. Indian Acad. Sci. B, **5**: 101, ff. 1, 2, 1937.

Trichomes enclosed in a sheath or without sheath, free floating, straight, slightly tapering at the apex ; apical cell flatly rounded ; cells barrel-shaped, deeply constricted at the cross-wall regions, 3.8-4.7 μ broad and 3.8 μ long ; heterocysts intercalary, almost spherical, 3.8-7.6 μ broad, 3.8-5.7 μ long ; spores formed singly on either side of the heterocysts, usually ellipsoidal, sometimes spherical also, 11.4-17.1 μ broad, 11.4-19.04 μ long (Plate II, figs. 18, 19).

Habitat: From Kaylana, Jodhpur. (22-9-59).

15. **Anabaena iyengarii** var. **attenuata** Rao, ibid. B, **8** : 163, f. 2A-C, 1938b.

Mucilaginous, pale blue-green ; trichomes irregularly curved, tapering at the ends, 3.8-5.7 μ broad ; cells barrel-shaped, 3.8-5.7 μ broad, 7.0-7.6 μ long, apical cell conical ; heterocysts barrel-shaped 5.7-7.6 μ broad,

7.6 μ long; spores ellipsoidal, single or in pairs on either side of the heterocysts, 13.2-15.24 μ broad, 17.1-19.0 μ long (Plate III, figs. 24, 25).

Habitat: From a pond near Lalsagar (23-9-59).

16. **Anabaena variabilis** Kütz. ex Born et Flah. Geitler 876, f. 558, 1932.

Thallus gelatinous; trichomes without sheath, 3.8-4.04 μ broad, constricted at the cross-wall regions, irregularly curved; apical cell conical; cells barrel-shaped, as long as broad, 3.8-4.04 μ broad, 3.8 μ long; heterocysts spherical or oval, 5.7-6.0 μ broad, 5.7-7.6 μ long; spores formed centrifugally in catenate series, not contiguous with heterocysts, 5.7-7.6 μ broad, 7.6-11.4 μ long (Plate II, figs. 11, 12).

Habitat: From Balsamand near Jodhpur (9-9-59).

17. **Anabaena variabilis** var. **ellipsospora** Fritsch in J. Indian Bot. Soc. **28**: 142, ff. 40-50, 1949.

Thallus gelatinous; trichomes flexuous, constricted at the cross-wall regions; apical cell elongate, occasionally the apical cell is heterocyst (Plate II, fig. 15); cells 3.8-4 μ broad, 7.6-9.5 μ long, generally elongate, cylindrical; heterocysts intercalary, solitary, spherical or barrel-shaped, 5.7 μ broad, 5.7-7.6 μ long, seldom terminal; akinetes ellipsoidal, more or less oblong, formed in catenate series away from heterocysts, 3.8-5.7 μ broad, 9.7-15.2 μ long (Plate II, figs. 15, 16, 17).

Habitat: From a pond near Lalsagar (27-9-59).

18. **Aulosira fertilissima** var. **tenuis** Rao in Proc. Indian Acad. Sci. B, **6**: 353, f. 3f-i, 1937b.

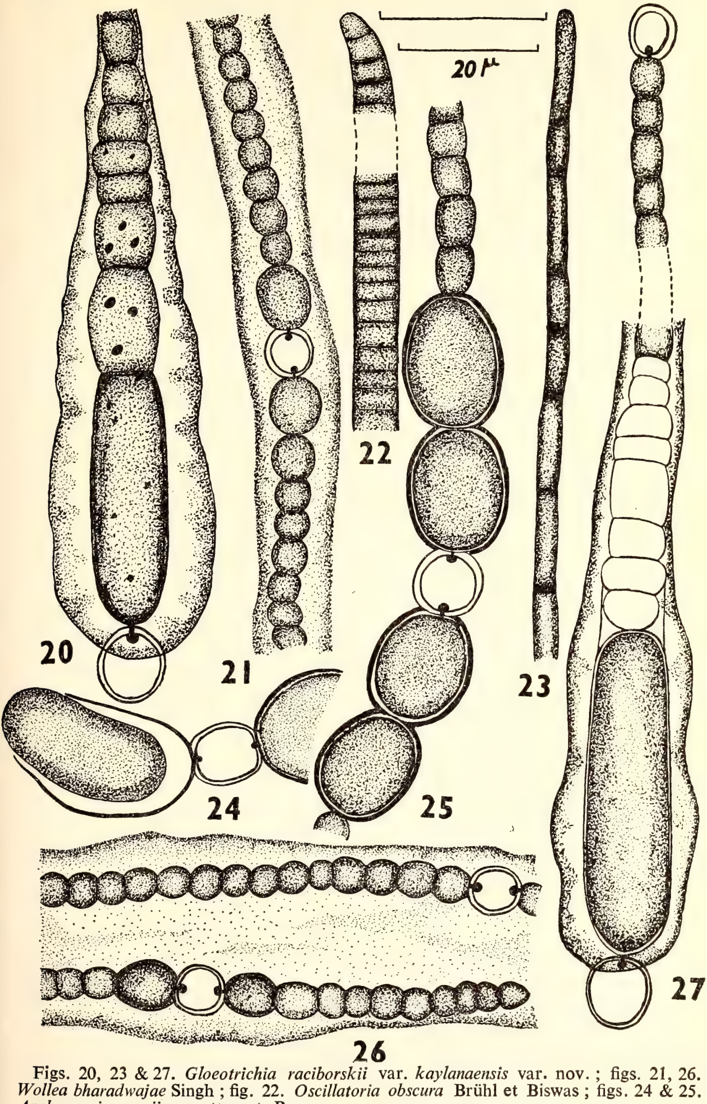
Plant mass expanded, membranous; trichomes straight, parallel; cells cylindrical or barrel-shaped, 3.8-5.7 μ broad and 3.8-5.7 (19.0) μ long, contents smooth, sheath thin; heterocysts intercalary, oblong or elliptical, 7.6-8.5 μ broad and 8.5-15.2 (19.0) μ long, slightly broader than the trichome (Plate II, fig. 14).

Habitat: Along with *Cylindrospermum stagnale* (Kütz.) Born et Flah.

19. **Gloeotrichia raciborskii** var. **kaylanaensis** var. nov.

Thallus efformat globulos sphaericos, natantes; trichomata desinunt in capillum longum, 1.9-3.8 μ latum ad apicem, cellulis ad basin trichomatis brevioribus sed gradatim evadentibus longioribus ad apicem, cellulis basalibus 7.6-8.5 μ latis, 3.8-5.7 μ longis. Heterocystes sphaerici, 8.5-9.5 μ lati, 7.6-11.4 μ longi, eorum parte operta vagina; sporae cylindricae, 11.4-15.2 μ latae, 38.0-49.4 μ longae; rarissime heterocystes apparent ad utrumque vel ad utrumvis filamenti latus.

Typus lectus ad Kaylana, proper Jodhpur die 8 octobris anni 1959, et positus in Laboratorio Algologico in Indian Agricultural Research Institute ad New Delhi sub numero *Myx-J*19.



Figs. 20, 23 & 27. *Gloeotrichia raciborskii* var. *kaylanaensis* var. nov. ; figs. 21, 26. *Wollea bharadwajae* Singh ; fig. 22. *Oscillatoria obscura* Brühl et Biswas ; figs. 24 & 25. *Anabaena iyengarii* var. *attenuata* Rao

Thallus forms spherical balls, floating; trichome ending into a long hair, 1.9-3.8 μ broad at the apex, cells shorter at the base of the trichome but gradually become longer towards the apex, at the base cells 7.6-8.5 μ broad, 3.8-5.7 μ long; heterocysts spherical, 8.5-9.5 μ broad, 7.6-11.4 μ long, a part of it covered over by the sheath; spores cylindrical, 11.4-15.2 μ broad and 38.0-49.4 μ long; very rarely heterocysts are found on either side of the filament (Plate III, figs. 20, 23, 27).

Habitat: From Kaylana, Jodhpur. (8-10-59).

Type: *Myx-J*19, Algal Laboratory, Indian Agricultural Research Institute, New Delhi-12.

This variety resembles *G. raciborskii* Woloszynska but differs from the same in the absence of lamellated sheath at the base and in having subspherical to oval heterocysts and narrower spores; differs from var. *bombayensis* Dixit in having broader trichomes and narrower heterocysts; differs from var. *conica* Dixit in the shape and size of the heterocysts and akinetes and in the nature of the basal sheath; differs from var. *kashiense* Rao in narrower trichomes, smaller heterocysts, and cylindrical spores, and from var. *longispora* Rao which has characteristically long akinetes. It agrees with var. *salsettense* Dixit in the dimensions of the trichomes, heterocysts, and akinetes, but differs in having much broader unlamellated sheath. Hence this form is treated as a new variety *kaylanaensis* var. nov.

The author is very grateful to Dr. G. S. Venkataraman of the Indian Agricultural Research Institute, New Delhi, for his kind guidance; to Prof. R. M. Bhandari, of Department of Botany, Jaswant College, Jodhpur, Rajasthan, for his encouragement; and to Fr. H. Santapau for kindly providing the latin diagnosis of the new form.

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Studies on the Biology of some Freshwater Fishes

Part I—*Ophicephalus punctatus* Bloch

BY

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(*With eight figures*)

General Introduction

It is surprising to note that, although the knowledge of aquatic biology has advanced considerably during the last two decades, very little has been written about the freshwater fishes of India. As compared to marine and estuarine fishes, the work so far done on the biology of freshwater fishes is of a fragmentary nature. Leaving aside the generalisations on the biology of practically every species made by Day (1878), and some studies on the breeding of food fishes in the Punjab and Bengal (Khan 1924, 1942 ; Hora 1945 ; Mookerjee *et al.* 1948), the larval stages and life history of some food fishes (Alikunhi & Rao 1951 ; Alikunhi 1953, 1956 ; Saigal & Motwani 1961), and the age and growth of mrigal, *Cirrhina mrigala* (Jhingran 1957, 1959), other information available is so diffused and scattered that no integrated picture of the biology of any species can be obtained.

Keeping in view the paucity of literature on the subject and the importance of the problem of successful inland fishery management and conservation of fish resources, attempts were made at Aligarh to study the biology of the most common freshwater fishes of this country. The present investigation covers a period of about two years during which time the following three species were investigated :

1. The common murrel, *Ophicephalus punctatus* Bloch
2. The common small barbel (carp), *Barbus stigma* (C. & V.)
3. The common catfish, *Callichrous bimaculatus* (Bloch).

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To maintain the continuity of the present account and to facilitate future publications on other fishes under the same heading, the authors find it best to present the biology of each species as a separate part.

1. *OPHICEPHALUS PUNCTATUS* BLOCH

Introduction

Ophicephalus punctatus Bloch, the common freshwater murrel of India, has an extensive geographical distribution. It is found in Ceylon, Burma, and all over the plains of India (Day 1878). Besides fresh water it has also been recorded from brackish water where it acquires a slightly purple colour (Raj 1916).

O. punctatus forms the mainstay of pond fishery in areas which are far removed from the sea. Being an air-breathing fish fairly large numbers can survive in practically all types of ponds, seasonal or perennial. During the summer months when seasonal ponds get dried, the fish buries itself in the soil and aestivates. Frequently the local fishermen obtain a regular supply of these aestivating fishes by digging one or two feet into the crusted soil. This fish being extremely hardy can be readily obtained in fresh condition, or even alive, at all times of the year. It thus forms a popular item of diet in practically all the states of northern India.

Earlier accounts on this species include comments on eggs and larvae and brief descriptions on nesting and breeding behaviour (Willey 1908 ; Raj 1916 ; Khan 1924 ; Mookerjee 1945 b ; Jones 1946 ; Hosaini & Rahimullah 1946). Recent accounts have dealt with the spawning frequency (Qasim & Qayyum 1961), parental care (Qayyum & Qasim 1962), and fecundity (Qasim & Qayyum 1963). No detailed study has been made on any other aspects of the biology of this fish.

Methods

Samples which formed the basis of the present investigation were collected from ponds in Aligarh by using cast nets at monthly intervals over a period of 19 months, from October 1958 to April 1960. Fishes were measured to the nearest millimetre and grouped at size intervals of 0.5 cm. After wiping off the moisture etc. from the surface of the body, fishes were weighed on a balance sensitive up to 0.1 gm. Gonads from each fish were dissected out, weighed, and assigned a proper stage of maturity. For studying the food, the guts of all fishes were taken out and the contents examined.

TABLE I

NUMBER OF FISH (*O. punctatus*) OF EACH LENGTH GROUP CAUGHT IN VARIOUS MONTHS

Length group	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June
cm.												
3.0	30	..	..	..	..	..	..	..	..	..	..	..
3.5	..	10	8	6	..	..	..	..	..	..	..	..
4.0	..	12	11	6	..	..	..	..	..	..	..	..
4.5	..	16	12	8	..	..	..	..	..	..	..	..
5.0	..	14	10	9	..	..	..	..	..	..	..	..
5.5	..	10	10	5	4	..	..	..	..	..	..	..
6.0	..	5	13	6	3	2	1	..	..	..	..	..
6.5	..	7	7	3	6	4	..	..	..	..	..	..
7.0	..	3	16	5	4	4	..	..	..	..	..	..
7.5	..	..	1	1	1	9	11	4	..	..	..	..
8.0	..	..	1	..	3	17	5	3	1	..	..	..
8.5	..	..	2	..	1	17	3	5	3	..	..	..
9.0	..	..	7	8	16	15	7	7	4	..	..	..
9.5	..	..	3	6	39	13	7	7	9	..	..	..
10.0	..	..	1	9	31	18	7	2	5	3	..	..
10.5	..	..	..	4	18	19	5	5	2	2	3	..
11.0	..	1	..	5	26	6	5	4	6	1	..	..
11.5	..	..	1	8	16	1	11	5	8	3	..	..
12.0	..	..	..	6	18	..	2	9	10	7	2	..
12.5	2	1	3	4	5	2	3	4	11	5	1	2
13.0	4	3	2	11	2	3	6	4	10	5	6	4
13.5	6	6	..	6	2	3	..	1	8	7	6	6
14.0	6	7	2	6	2	4	3	2	4	9	3	6
14.5	7	8	2	3	..	3	4	4	5	8	7	7
15.0	9	8	4	3	2	4	2	1	3	5	7	9
15.5	6	9	6	5	2	3	4	1	3	5	5	6
16.0	4	6	6	4	1	2	5	1	3	3	1	4
16.5	3	6	2	3	6	2	4	..	..	2	1	3
17.0	2	4	..	..	1	6	1	2	3	4	2	2
17.5	1	4	4	..	6	4	6	1	1	2	1	..
18.0	1	..	1	3	2	3	3	4	..	1	..	1
18.5	1	1	3	..	2	..	3	..	1	5	..	1
19.0	..	2	1	..	2	2	1	1	1	2	2	1
19.5	2	3	..	2	..	2	2	4	..	1	2	5
20.0	..	6	..	..	..	..	6	1	..	1	2	..
20.5	..	4	..	1	1	..	4	..	..	2	1	
21.0	1	1	1	3	1	1	..	1	..	1	1	..
21.5	2	1	..	1	1	2	..	3	..	..	2	..
22.0	..	1	..	1	..	..	2	..	2	1	2	1
22.5	..	2	..	..	2	..	1	..	1	2	2	..
23.0	2	2	..	..	..	1	..	3	..	..	2	4
23.5	..	4	1	1	..	1	..	..	1	3	..	2
24.0	..	..	1	1	..	..	..	1	1	1	2	..
24.5	..	1	..	2	..	..	..	1	2	..	1	..
25.0	1	..	2	1	..	..	..	1	..	2	..	..
25.5	..	1	1	..	..	..	..	..	2	2	1	..
26.0	2	1	..	..	2	..	..	..	..	..	1	..
26.5	..	..	..	..	1	..	..	2	..	..	1	..
27.0	..	..	..	..	..	..	..	..	..	..	2	..
27.5	1	..	2	..	..	..	..	..	..	..	..	..
28.0	2	..	..	..	..	..	..	..	..	..	..	..
28.5	..	..	..	..	..	..	..	..	..	..	..	..
29.0	..	..	..	..	..	..	..	..	..	..	1	..
29.5	..	..	..	..	1	..	1	..	..	..	..	..
Total	95	170	147	156	230	173	125	94	110	95	70	64

LENGTH FREQUENCY DISTRIBUTION

The data pertaining to the length frequency distribution of each month are given in Table I, after grouping for various duplicate months. Since it was not possible to follow the progression of various modes from month to month, the data for the entire period of observation were pooled in four quarters, each of three months. These are shown as histograms in Fig. 1. The various modes that could be judged by these histograms have been drawn arbitrarily in the figure.

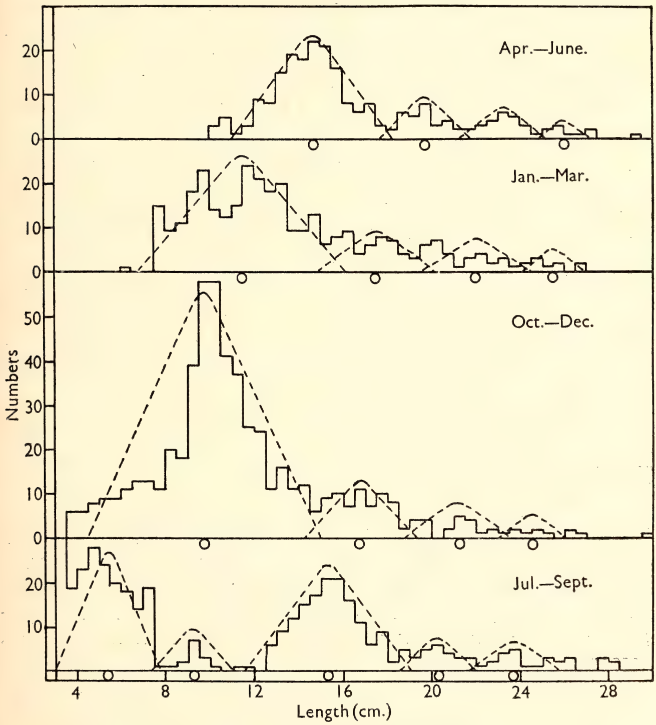

FIG. 1. Length frequency distribution of *O. punctatus*

Open circles indicate average size of each year class as revealed by the modes in the histograms. Possible modes marked arbitrarily by dotted lines.

From Fig. 1 the first three or four year-classes can be clearly demarcated. Size groups below 3.0 cm. in length have not been included in the histograms as these include larval fishes. The breeding season of the fish being June-October, the larvae begin to appear from July and continue to do so till October (Qayyum & Qasim 1962).

The histogram relating to the months of July-September shows modes at four different points : (1) at 5.4 cm., (2) at 15.3 cm., (3) at 20.2 cm., (4) at 23.8 cm. The group represented at 5.4 cm., apparently relates to the brood hatched during June and July (0 group) while the others seem to correspond to older year classes, probably one, two, and three. A small mode following the 0 group fishes at 9.2 cm. seems difficult to interpret. Probably these fishes are one year old and have come from an environment where their growth was slower than usual. This mode though marked in the histogram of July-September could not be followed in other seasons and for this reason it has been excluded from further interpretations.

The histogram for the months October-December also shows four distinct modes. The 0 group which was previously at 5.4 cm. now appears at 9.7 cm. The other groups with their average sizes of 15.3 cm., 20.2 cm., and 23.8 cm. in the previous quarter have shifted to 16.7 cm., 21.2 cm., and 24.5 cm. respectively.

The histogram for the months of January-March can also be demarcated into four modes. The 11.5 cm. group refers to 0 group which has shifted during this period from 9.7 cm. Other groups represented by modes at 17.5 cm., 22.0 cm., and 25.5 cm. in these months belong to first, second, and third year classes.

The histogram for the months of April to June again shows four distinct modes at 14.5 cm., 19.8 cm., 23.2 cm., and 26.0 cm. These indicate that further growth in all the four year classes has occurred in these months also.

The average size of the first four year classes as indicated by the size frequency histograms is given in Table II together with their range in length during each quarterly season. As can be seen from this table the growth is rapid in the first year when the fish reaches approximately 14.5 cm. in length. During subsequent years, it slows down progressively. There appears to be little difference in growth during various seasons.

TABLE II

AVERAGE LENGTH OF VARIOUS YEAR CLASSES OF *O. punctatus* OBTAINED FROM THE LENGTH FREQUENCY DISTRIBUTION OF VARIOUS QUARTERS TOGETHER WITH THE SIZE RANGE OF EACH YEAR CLASS

Year Classes	Months	Range in size	Average length
		cm.	cm.
0	July - Sept.	3.0 - 7.8	5.4
	Oct. - Dec.	4.5 - 15.0	9.7
	Jan. - March	6.8 - 16.1	11.5
	Apr. - June	11.2 - 18.3	14.5
1	July - Sept.	11.5 - 19.0	15.3
	Oct. - Dec.	14.2 - 19.2	16.7
	Jan. - March	14.9 - 20.1	17.5
	Apr. - June	17.8 - 21.8	19.8
2	July - Sept.	18.5 - 22.0	20.2
	Oct. - Dec.	18.8 - 23.4	21.2
	Jan. - March	19.6 - 24.6	22.0
	Apr. - June	21.3 - 25.1	23.2
3	July - Sept.	21.8 - 25.8	23.8
	Oct. - Dec.	23.0 - 26.1	24.5
	Jan. - March	24.1 - 27.0	25.5
	Apr. - June	24.8 - 27.1	26.0

BREEDING

(*a*) *Stages of Maturity*

More or less similar to the scheme given for *Blennius pholis* L. and *Centronotus gunnellus* (L.) (Qasim 1957 a & b), five stages of maturity were drawn on the basis of the general appearance of gonads as follows :

	FEMALES	MALES
Stage I	*Immature virgins*	*Immature virgins*
	Ovaries very small, translucent, measuring 0.7 to 1.8 cm. in length. Elongated and cylindrical, rather oblong in shape. Light red in colour. Eggs microscopic. Gonad weight 0.008 to 0.058 gm.	Testes pinkish and translucent, very small, 0.3 to 0.5 cm. in length. Gonad weight 0.001 to 0.005 gm.

	FEMALES—(*Continued*)	MALES—(*Continued*)
Stage II	*Maturing virgins or recovered spents*	*Maturing virgins or recovered spents*
	Ovaries slightly enlarged occupying more than one-third of the body cavity. Flesh-coloured. Gonad weight 0.002 to 0.402 gm.	Testes pinkish and opaque, still small, slightly distended. Gonad weight 0.003 to 0.082. gm.
Stage III	*Ripening*	*Ripening*
	Ovaries enlarged and occupying more than half of the body cavity, pinkish yellow in colour. Two groups of eggs visible to the naked eye. Gonad weight 0.092 to 1.850 gm.	Testes flesh-coloured, opaque, distended in girth. Gonad weight 0.008 to 0.098 gm.
Stage IV	*Ripe*	*Ripe*
	Ovaries very much enlarged, occupying the whole of the body cavity. Yellow in colour, eggs rounded, large, yellow and opaque. Gonad weight 1.23 to 16.8 gm.	Testes dull pinkish. Distended in girth. Gonad weight 0.009 to 0.112 gm.
Stage V	*Spent*	*Spent*
	Ovaries flesh-coloured, flaccid, and shrunken, with some residual eggs. Gonad weight 0.047 to 1.10 gm.	Testes shrunken and dull reddish. Gonad weight 0.003 to 0.065 gm.

(*b*) *Size at First Maturity*

To determine the minimum size at first maturity total numbers of each sex at various maturity stages were tabulated. These are given in Table III. It can be seen from the table that in both sexes, individuals measuring from 5 to 10 cm. in length belong to the immature virgin class (Stage I). Fishes larger than 10 cm. show the next higher stage of maturity (Stage II). In 11 and 12 cm. size groups all the five maturity stages are found. The smallest ripe fishes (Stage IV) in both sexes were recorded in 11 cm. group and these were mostly found in July and August as they mature for the first time and spawn late during the breeding season. Their maximum ripeness in these months is in contrast to older age groups which show peak maturity in May and June. It can thus be concluded that both sexes mature when they are about 11 cm. in length and spawn for the first time when they are about one year old.

TABLE III

MATURITY STAGES OF *O. punctatus* IN VARIOUS LENGTH GROUPS

Maturity Stages		Length in cm. 5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
MALE	I.	33	28	33	38	74	75	20	3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	II.	..	..	..	..	..	..	30	42	38	22	16	10	14	7	10	7	12	4	6	5	2	4	1	..	2
	III.	..	..	..	..	..	..	1	2	11	15	13	4	4	2	..	5	2	2	1	2	5	1	..	..	..
	IV.	..	..	..	..	..	..	2	2	5	12	13	10	8	5	7	5	1	3	10	3	5	3	3	2	1
	V.	..	..	..	..	..	..	5	..	..	4	13	6	6	5	1	6	2	2	4	3	2	2	1	..	..
FEMALE	I.	29	29	26	23	74	59	7	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	II.	..	..	..	..	..	..	36	40	27	14	16	21	12	9	8	5	3	4	1	1	..	..	..	..	..
	III.	..	..	..	..	..	..	1	2	11	11	6	..	5	2	4	..	1	3	2	..	..	..	..	..	..
	IV.	..	..	..	..	..	..	4	1	10	25	21	12	5	5	8	1	..	1	..	..	..	..	..	..	..
	V.	..	..	..	..	..	..	1	1	9	9	14	9	3	1	..	..	2	1	3	..	..	..	..	..	..

(*c*) *Sex Ratio*

Out of 1410 fishes which were sexed during the entire period of observation, 772 were males and 638 were females (Table IV). This shows that in the population, males are in the majority. The largest male obtained was of 29.7 cm., whereas the size of the largest female was 24.3 cm. Fishes larger than 24.3 cm. were all males in the sample. Probably the males have either a faster growth rate or they have a greater longevity.

TABLE IV

NUMBER OF FISH (*O. punctatus*) AT EACH OF THE FIVE MATURITY STAGES IN EACH MONTH

Month	Sex	Maturity Stages					Total
		I	II	III	IV	V	
October	Male	12	10	..	..	11	33
	Female	7	6	..	..	10	23
November	Male	65	32	..	..	..	97
	Female	44	18	..	..	..	62
December	Male	27	16	..	..	..	43
	Female	26	15	..	..	..	41
January	Male	22	21	..	..	..	43
	Female	18	11	..	..	..	29
February	Male	9	12	..	..	..	21
	Female	7	12	..	..	..	19
March	Male	9	18	5	..	..	32
	Female	7	14	3	..	..	24
April	Male	2	8	15	1	..	26
	Female	..	7	9	1	..	17
May	Male	2	4	10	19	..	35
	Female	..	5	11	19	..	35
June	Male	..	2	7	23	..	32
	Female	..	2	6	24	..	32
July	Male	..	2	6	20	8	36
	Female	..	..	3	20	6	29
August	Male	21	..	3	27	22	73
	Female	18	..	3	20	18	59
September	Male	31	2	..	9	16	58
	Female	39	6	..	..	13	58
October	Male	28	7	..	..	9	44
	Female	21	9	..	..	6	36
November	Male	23	16	..	..	..	39
	Female	16	16	..	..	..	32
December	Male	25	22	..	..	..	47
	Female	19	23	..	..	..	42
January	Male	11	18	..	..	..	29
	Female	9	15	..	..	..	24
February	Male	8	18	..	..	..	26
	Female	8	20	..	..	..	28
March	Male	5	14	7	..	..	26
	Female	6	16	6	..	..	28
April	Male	4	10	17	1	..	32
	Female	2	2	7	9	..	20
Total	Male	304	232	70	100	66	772
	Female	247	197	48	93	53	638

(d) Spawning Cycle

In both sexes the various stages of maturity obtained in each month are given in Table IV and shown in Fig. 2. As can be seen from the figure, from September onwards the population mainly includes maturing fishes or recovered spents. No further advance over this maturity stage is seen until February. In March ripening stage begins to appear and in April this stage becomes predominant. In May and June both sexes reach peak ripeness (Stage IV) and from July onwards as the fish begin to spawn both ripening and ripe stages continue to occur until September. Though spent fishes start appearing in late July their main proportion in the population is not seen until August and September. The presence of large number of ripe fishes from May to September indicates that the breeding season lasts from June to October. As has been shown elsewhere (Qasim & Qayyum 1961), the ripe ovaries of every female contain more than one group of ova and thus there is every likelihood that each individual may spawn more than once during the breeding season. The continued occurrence of ripening stage as a predominant feature in breeding months strongly suggests that such an overlap in the cycle may be due to repeated spawnings of each individual.

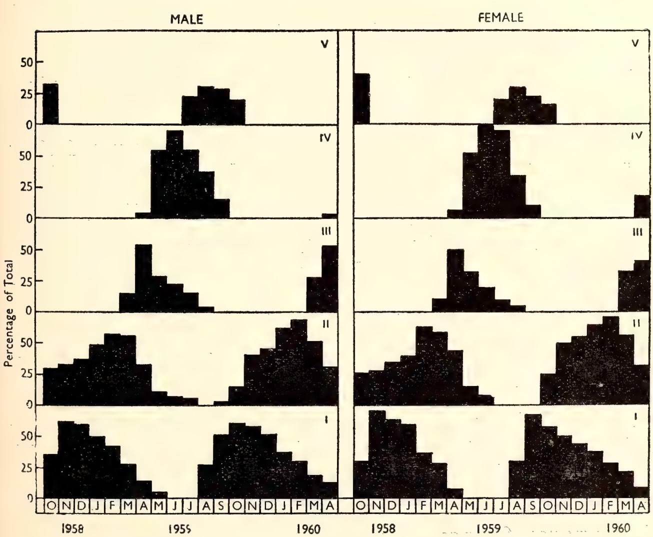

FIG. 2. Percentage of *O. punctatus* at each of the five stages of maturity in different months

(e) Seasonal Changes in Gonad Weight

Fig. 3 shows the seasonal changes in the gonad weight of both sexes. The data referring to the weight of gonads in each month have been expressed as a percentage of body weight. It can be seen from the figure that the curves for males and females follow almost the same pattern but for the fact that seasonal changes in the weight of testes are very slight.

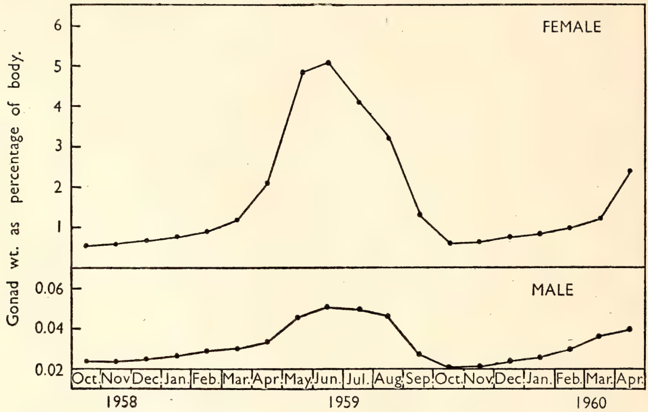

FIG. 3. Seasonal variation in gonad weight as percentage of body weight of *O. punctatus*

The testes remain in a resting condition till January and show no noticeable change in their weight. From March onwards they begin to increase in weight which reaches its maximum in June. After June there is a slow decline and the minimum gonad weight is recorded in October. This gradual decline suggests that the males also remain ripe over a long period and, like the females, do not become spent after the early spawnings.

The ovaries gain considerable weight in pre-spawning months and reach their peak condition in June. From July they register a fall in their weight which continues till October.

The cycle of gonad weight clearly indicates the spawning season of this fish. Maximum values obtained in both sexes during July signify peak maturity in that month. Its fall during subsequent months which is associated in all probability with spawning provides further evidence that the spawning season of the fish lasts from June to October.

(f) Occurrence of Larvae

The larvae of this fish guarded by both parents are of common occurrence in shallow areas of ponds (Qayyum & Qasim 1962). The first

batch of larvae was seen on 2 July and the last batch on 23 October. In the former batch the larvae on an average measured 1.5 cm. whereas in the latter they were 2.5-2.8 cm. in length. From the size of the larvae of the first batch it can be inferred that they must be about 8-10 days old. The fish, therefore, begins to spawn in the last fortnight of June. That the spawning season lasts till October becomes evident from the fact that the last batch of larvae which measured 2.5-2.8 cm. in length must be about three weeks old.

In *O. punctatus* several earlier authors have observed the occurrence of larvae at different times of the year. In Bengal its breeding season seems to last from June to August (Mookerjee 1945 b). In Ceylon, Willey (1908) reported newly hatched larvae in April and May. According to Raj (1916) at Madras, *O. punctatus* breeds twice in a year—first in January and February and again in July and August. Jones (1946) has seen a number of broods in August and September at Madras, while Hosaini & Rahimullah (1946) concluded that *O. punctatus* breeds throughout the year in Hyderabad. From these accounts it appears that this fish may have two breeding seasons in south India corresponding to two monsoons. In northern India it has only one breeding season which lasts from June to October.

(g) *Spawning Periodicity*

Studies on the size frequency distribution of oocytes have indicated that the ovaries of *O. punctatus* contain two well defined groups of maturing ova (Qasim & Qayyum 1961). This raised the possibility that like *B. pholis* (Qasim 1956a, 1956b) this fish may also have a succession of spawnings during the breeding season. To confirm this, an aquarium study was arranged but every effort to persuade the fish to breed in captivity remained fruitless. Further evidence of such breeding behaviour was obtained by studying the spawning periodicity of the fish as based on ova-diameter measurements.

During the breeding season, ovaries from several specimens were fixed in 10% formalin at fortnightly intervals. A small portion of the ovary from the middle region was then taken and all the eggs contained in it were separated and measured under a micrometer eye-piece. Usually 500-1000 maturing eggs were measured from each fish. In making measurements, the oocytes smaller than 0.2 mm. were not considered as they occurred throughout the year.

On plotting the percentage frequency of all the measured eggs from each fish it appeared that there was a great deal of individual variation in the same month, particularly after the spawning season began. Typical conditions were, however, laid down on the basis of their relative predominance in various months. These are shown in Fig. 4.

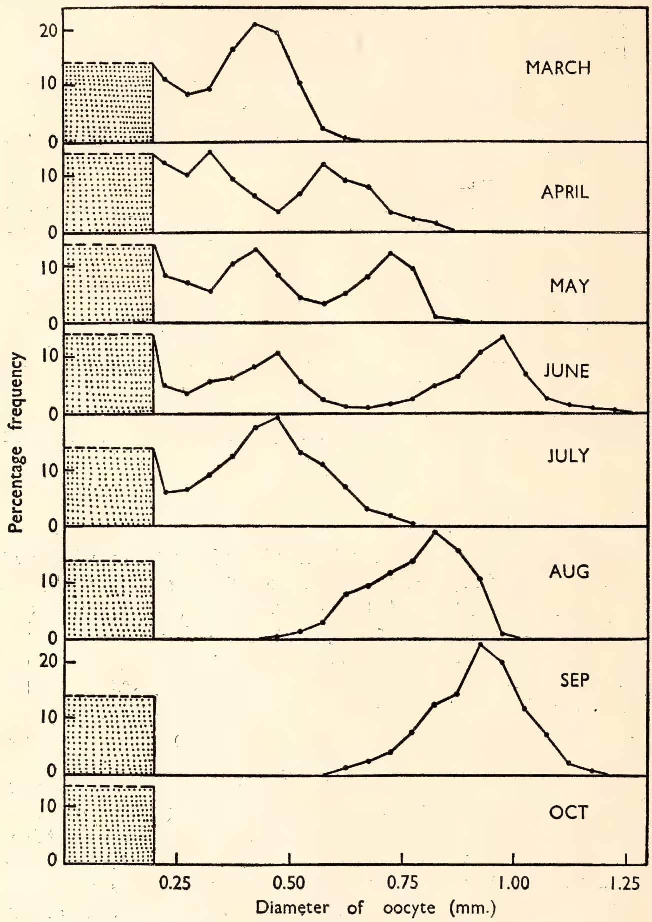

FIG. 4. Size frequency distribution of intra-ovarian eggs of *O. punctatus* from March to October

Stippled areas show small, immature eggs which were not measured.

In March when most fishes reach maturing stage (Stage II), the gonads show only one batch of eggs with a peak at 0.45 mm.—the maximum size of eggs being 0.65 mm. In April the size of eggs increases markedly

and there are two distinct batches, one of ripening eggs with a peak at 0.55 mm. and the other which includes immature eggs has an average size of 0.30 mm. In May these two batches become well defined. Most fishes in this month attain the ripening stage (Stage III). In June when the fishes are mostly ripe (Stage IV) these two groups become widely separated. The larger eggs attain an average diameter of 0.95 mm., whereas the immature eggs have an average size of 0.45 mm. The condition shown in Fig. 4 for July was obtained from parent females which were captured while exhibiting brood care. In most of the parent females the condition revealed by the ovaries was similar to that shown for July. In August there was again a considerable overlap in the ova-diameter frequencies as the ovaries of the late spawners which mainly include juvenile fishes show more or less condition depicted for May or June. These fishes which are maturing for the first time have two groups of eggs. However, in August many large-sized females had only one group of eggs as shown in Fig. 4. These eggs attain a maximum size of 0.95 mm. with its peak at 0.8 mm. In September, as the only group of eggs present in the ovaries becomes fully mature, the peak shifts to 0.9 mm. and the maximum size of eggs reaches 1.2 mm. In October when the fishes are completely spent (Stage V) the ovaries contain very small oocytes measuring less than 0.25 mm. In this month also the juveniles have an exception of having another group of small eggs present. Presumably in these fishes the second group of eggs is retained in the ovaries and is finally resorbed during subsequent months.

Thus by following the growth of both batches of eggs during the breeding season it becomes clear that at least in large-sized females of the population, both groups of ova are matured and shed in succession during the same breeding season.

(*h*) *Condition Factor*

The coefficient of condition or ponderal index forms an important part of fishery research and it has often been used to provide additional information about spawning, feeding, and other aspects related to the well-being of fish (Le Cren 1951). In the present investigation the condition factor of each fish was calculated by the formula suggested by Hile (1936):

$$K = \frac{W \times 100}{L^3},$$

where W=weight in gm., L=length in cm., and K=condition factor.

The figures obtained from each fish throughout the period of observation were pooled in two ways to find the arithmetical means of each size group and of each month. These have been plotted in Figs. 5 and 6.

As can be seen from Fig. 5, in both sexes the K values increase steadily

up to 19 cm. in length. Thereafter, the values begin to fall and reach their minimum at a length of 24 cm. in females and at 29.5 cm. in males.

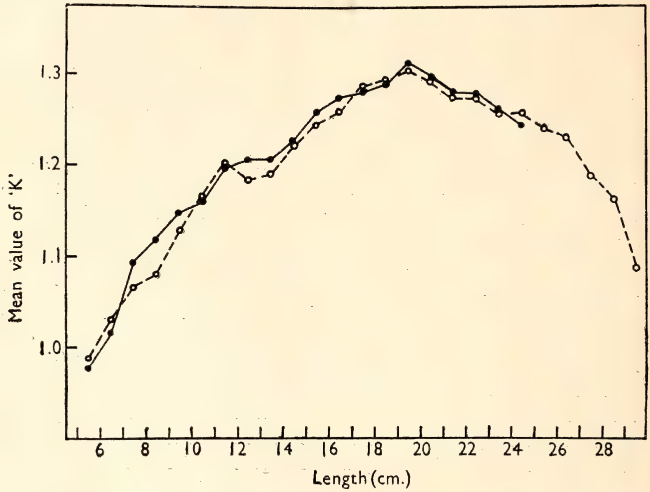

FIG. 5. Mean condition factor (K) of *O. punctatus* at different lengths

Of females, continuous line ; of males, broken line

Hart (1946) pointed out that, since the adolescent fishes have higher K values than the older fishes, the increase and decrease in the K values related to the increasing length can be employed to determine the size at first maturity. This feature has often been applied successfully in many forms (Menon 1950 ; Pillay 1954 ; Sarojini 1957).

In the present case as can be seen from Fig. 5, the actual point of inflection in the curve which is at 19 cm. does not correspond to the size at first maturity as has been established by a more direct evidence. However, at 11 cm. there is a tendency in the curve to change slope. This feature is more marked in males than in females. One may regard this point as that corresponding to the point of inflection, which agrees well with the size determined by an observation of the seasonal changes in the gonad condition. The secondary fall in the condition factor noticed in larger fishes of both sexes, starting from 19 cm. (Fig. 5), is probably because of increasing metabolic strain due to spawning in older age groups. Perhaps with increase in age senility sets in and complete recovery which contributes towards reserve building and increase in weight gradually

declines. Presumably this is the reason of their being poorer in condition factor than the younger breeders.

Several factors have been pointed out by earlier investigators to affect the condition of fishes. Fluctuation in the gonad weight is the main factor which seems to regulate the condition factor (Le Cren 1951 ; Morrow 1951). The other factor which seems to govern the rise and fall of K values is the feeding rate of fish (Qasim 1957a ; Bal & Jones 1960).

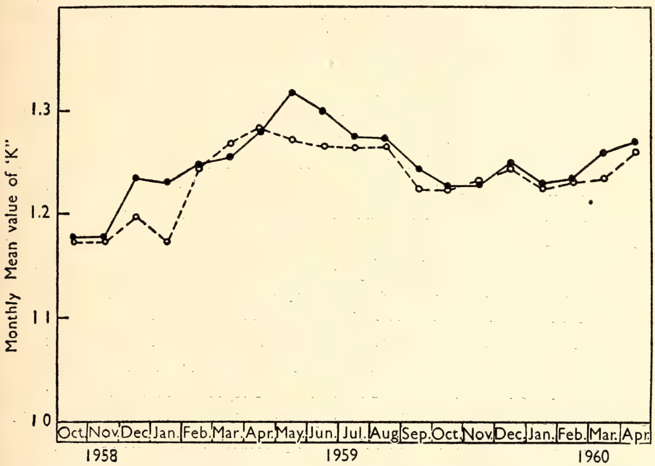

FIG. 6. Seasonal changes in the condition factor (K) of *O. punctatus*
Of females, continuous line; of males, broken line

The seasonal variation in the condition factor has been illustrated in Fig. 6. In calculating the mean for each month, the K values of immature fishes were neglected and the data related to each month refer to the adolescent and older age groups only. As Fig. 6 will indicate, in females the condition factor is lowest in October and November. In December it increases rapidly and reaches its maximum in May. From June onwards it records a steady fall which continues till October. In males except for the lowest value which is obtained in January, the condition factor follows fluctuations similar to those shown by the females. Maximum values in both sexes coincide with the time when gonads reach peak maturity. Their consistent decline from June to October may be attributed to spawning. The time of the poorest condition factor (October and November) is probably due to complete loss of reserve, for both sexes remain busy in brood care until October. From December onwards the rise and fall in the condition factor seem entirely related to the cycle of feeding. A secondary rise in December is probably due to

general building up of body reserves as the intensity of feeding in preceding months is relatively high (see page 98).

Food and Feeding Habits

Little is known about the food and feeding habits of this fish. Brief references have been made earlier which indicate that *O. punctatus* is carnivorous, its food consisting of insects, crustaceans, and fishes (Alikunhi & Rao 1947 ; Mookerjee *et al.* 1946a). Its larvae have been noted to feed on unicellular algae and protozoans (Mookerjee *et al.* 1946b).

A detailed study which includes qualitative and quantitative analysis of food was made on the basis of gut contents as follows :

Guts of all the fishes collected in each month were dissected out and the contents of each were carefully removed in petri-dishes containing water and examined under a dissecting microscope. Each item of food contained in the gut was listed and expressed as a percentage of the total number of guts examined which contained food in that month. In other words the method of the analysis of food was the frequency occurrence method (see Hartley 1947 ; Qasim 1957a, 1957b).

Practically all samples used for the present investigation were collected during the forenoon, from 7.00 a.m. to 12 noon. It can therefore be presumed that the food of all samples was subjected to the same amount of digestion and that any diurnal rhythm in feeding was also avoided.

As there were differences in the food preferences of various size groups, it was considered necessary to maintain a separate record of each fish. Later on the fishes were grouped into the following three heads and the food of each group was analysed separately :

1. Adolescent and older fishes,
2. Immature fishes,
3. Larvae.

(*a*) *Food of adolescent and older fishes*

This group includes fishes from 10 cm. to 29.7 cm. in length. In all, 1047 fishes of this size range were examined. Of this, 895 were found to contain food. Table V shows the percentage occurrence of different items of food during the entire period of observation. It can be seen from the Table that *O. punctatus* is predatory in habit and that other forage fishes form its main food. Besides these, the fish also consumes insects, gastropods, prawns, and algae. Fig. 7(A) shows the frequency of occurrence of various categories of food. In this figure the various food items given in Table V have been grouped into four main heads : (a) fish, (b) insects, (c) crustaceans, and (d) miscellaneous organisms.

TABLE V

PERCENTAGE OCCURRENCE OF VARIOUS CATEGORIES OF FOOD IN THE GUTS OF ADOLESCENT AND OLDER FISHES (*O. punctatus*)

Month	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
No. of fish examined	50	122	39	45	26	45	43	70	64	65	93	46	29	39	73	50	46	50	52
No. of fish with food	43	102	33	38	23	42	41	62	51	49	71	39	25	34	61	46	40	46	49
Barbus stigma	72.1	77.4	57.6	42.1	34.8	47.6	68.3	56.4	45.1	36.7	47.9	53.8	84.0	67.6	44.3	47.8	45.0	58.7	61.2
Esomus danricus	18.6	27.4	15.1	15.8	26.1	28.7	9.7	17.7	11.8	14.3	4.2	20.5	..	26.5	8.2	6.5	10.0	17.4	14.3
Trichogaster chuna	..	..	..	2.6	..	..	2.4	..	..	..	2.8	..	..	..	..	..	..	..	..
Mystus sp.	..	..	3.0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Ophicephalus punctatus	..	1.0	..	..	4.3	2.4	..	..	..	..	1.4	..	..	..	..	..	..	..	..
Amblypharyngodon mola	..	..	..	..	..	..	..	..	..	..	1.4	..	..	..	..	..	..	..	..
Callichrous pabda	..	..	..	..	..	..	..	..	..	..	1.4	..	..	..	..	..	..	..	..
Digested fish	4.6	7.8	3.0	5.3	8.7	9·5	7.3	1.6	15.7	26.5	11.3	15.4	4.0	5.9	16.4	4.3	7.5	10.7	4.1
Hemiptera	6.9	15.7	12.1	15.8	17.4	23.8	31.7	14.7	15.7	10.2	8.4	5.1	12.0	11.8	18.0	13.1	12.5	2.8	4.1
Odonata	..	2.0	9.1	18.4	26.1	9.5	2.4	..	2.0	..	..	..	4.0	..	11.5	17.4	15.0	6.5	..
Coleoptera	2.3	..	6.1	10.5	17.4	11.9	4.9	4.9	5.9	8.2	2.8	..	..	2.9	3.3	6.5	2.5	..	..
Diptera	..	..	3.0	..	4.3	7.1	2.4	..	3.9	..	..	..	..	..	6.5	6.5	12.5	8.7	14.3
Digested insect	2.3	..	6.1	7.9	13.0	11.9	19.5	9.8	13.7	16.3	4.2	12.8	..	2·9	6.5	2.2	10.0	13.0	10.2
Gastropod	11.6	5.8	9.1	10.5	4.3	2.4	..	1.6	..	10.2	14.1	5.1	8.0	8.8	6.5	15.2	5.0	..	2.0
Prawn	2.3	2.0	..	2.6	..	..	2.4	..	..	..	2.8	2.6	..	..	1.6	..	..	..	..
Algae	..	..	..	2.6	4.3	4.8	..	..	..	..	..	..	..	..	..	..	..	..	..
Higher aquatic plants	..	..	3.0	..	..	..	..	..	..	2.0	1.4	..	..	..	..	..	..	..	..
Water spider	2.3	2.0	..	..	..	..	..	1.6	..	..	..	..	..	..	..	..	..	..	..
Frog	..	1.0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

As can be seen from the figure, fish form the dominant food throughout the year. During the pre-monsoon (March-June) and post-monsoon months (Oct.-Nov.), the occurrence of fish in the guts is relatively higher. This is probably due to the fact that during the pre-monsoon months, when the quantity of water in ponds has considerably receded, the fish

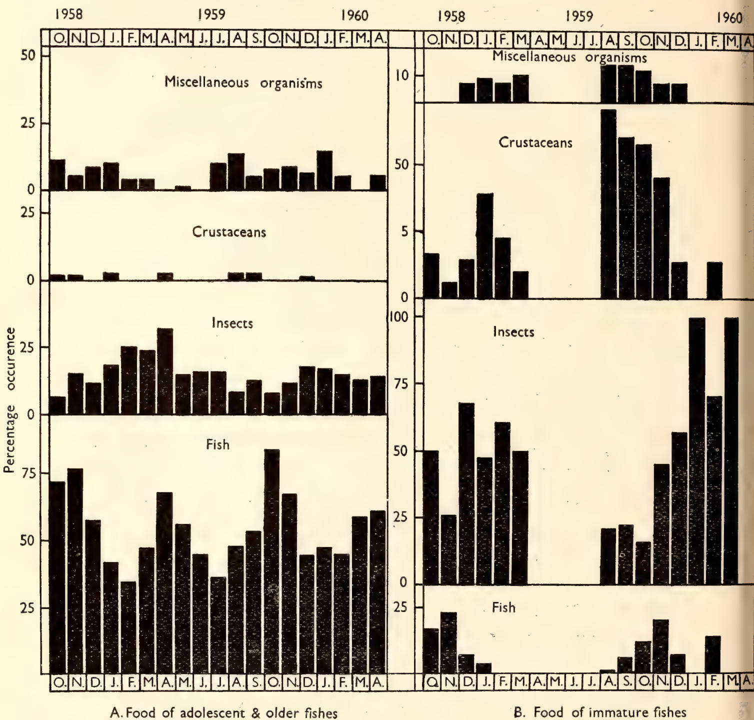

FIG. 7. Histograms showing the percentage occurrence of principal items of food of *O. punctatus* in different months

gets a better chance of catching other small fishes. In the post-monsoon months, soon after the breeding season of other fishes is over, small metamorphosed fishes belonging to the current year's brood become abundantly available in ponds. In these months the guts of *O. punctatus* largely contained small fishes.

In all, seven species of fish were found in the guts (Table V). Of these, *Barbus stigma* was predominant and occurred in all the months of

the year. It constituted 68.5% of the total fish food. Frequently the guts contained no other food except *B. stigma*.

Esomus danricus was the other fish ingested. It occurred in almost all the months of the year. The maximum number (28.7%) of the guts containing this fish was obtained in March 1959.

Other fishes *Trichogaster chuna*, *Amblypharyngodon mola*, *Mystus tengara*, and *Callichrous pabda* occurred rarely in the guts. There were four instances when smaller *O. punctatus* were recorded in the guts of larger fishes. Such fishes contained nothing else but *O. punctatus*, suggesting that cannibalism in this species is rare and possibly occurs when no other food is available. Parents, however, have never been found to contain any young ones of their own kind in their guts (Qayyum & Qasim 1962).

Digested fish remains in the gut were of common occurrence throughout the period of observation. These were difficult to identify and sometimes included scales, bones, and other fish remains.

Insects formed the next important item of food. Practically all the insects found in the guts were aquatic species. Hemiptera, Odonata, Diptera, and Coleoptera constituted the main groups of insects. In pre-monsoon months (March-June), the frequency of occurrence of insects was the highest.

From the hemipterous group, water bugs (*Corixa*, *Notonecta*, *Garris*, and *Nepa* spp.) were the commonest organisms. Of these, the former two occurred all the year round and showed little fluctuations whereas the latter two were rather rare. The maximum number of guts containing these insects was in April 1959.

Nymphs of dragon fly (Odonata) were also of frequent occurrence in the guts. During winter months (December-February), the percentage occurrence of nymphs was relatively higher.

Other insects present in the gut were beetles (Dytiscidae) and fly larvae and pupae (chironomid). Beetles were not very frequent and their numbers in the gut were also few. Chironomid larvae, on the other hand, were abundantly found in the pre-monsoon months. They mostly occurred in smaller fishes and were seldom present in fishes larger than 15 cm. Mosquito-larvae were recorded only from two guts.

Gastropod shells were of consistent occurrence in the gut. During the entire period of investigation, three months were the only exceptions when they were not recorded (Table V). Seven fishes contained prawns and three contained water spiders.

Algae and leaves of higher aquatic plants were rarely eaten. Filamentous algae (*Spirogyra* and *Oscillatoria*) were negligible in proportion and seem to be ingested along with other food organisms. They, however, occurred from January to April.

Frog bones were found in the gut of one fish measuring 19 cm. in length.

In the light of all the food organisms ingested, it seems that adolescent and older fishes are mid and surface feeders. Fishes such as *B. stigma* and *E. danricus*, which are readily eaten by *O. punctatus*, are pelagic species and are likely to occur throughout the column zone, from surface to the bottom. The presence of insects such as *Corixa*, *Notonecta*, and dragon fly nymphs in the gut which are mainly surface dwellers seem to confirm the surface feeding habit. The other murrel *Ophicephalus striatus* has been previously reported as a bottom feeder (Das & Moitra 1956), which seems unlikely because its main food as suggested by these authors includes insects and fishes.

The greater occurrence of fish in the gut suggests that the larger fishes are mainly piscivorous. Insects and other food organisms are of secondary importance for the large-sized fishes as the fish measuring 22 cm. and above hardly contained anything else except fish. The occurrence of insects and other organisms was mostly in smaller fishes. The greater proportion of *B. stigma* in the food and its consistent occurrence throughout the year suggest that *O. punctatus* has a marked preference towards this fish.

(*b*) *Food of Immature Fishes*

Fishes ranging from 3.5 cm. to 9.9 cm. were kept in this category. The total number of guts examined of this size range was 438, of which 390 contained food. As the fish of this size range were only available from August to March, it became possible to make analysis of their guts only in these months. The percentage occurrence of various categories of food of the immature fish is shown in Table VI.

It is clear from the table that the food preferences of the immature fishes differ considerably from those of the older fishes. Some such organisms as Ephemeroptera nymphs, copepods, daphnids, and other crustaceans, which are never eaten by the older fishes, are included in the diet. Fig. 7(B) shows the percentage occurrence of the main categories of food in various months.

As can be seen from the figure, for this size group, fish does not form the major item of food. Of the total number of guts examined only 8.0% contained fish. This is in contrast to the previous size group where fish was found in 68.5% guts. Even in this size group, whenever fish was recorded in the gut it was in those specimens which were of relatively larger size. Evidently the smaller fishes are incapable of catching other fishes, but as they grow bigger they begin to hunt for them.

Insects (Diptera, Hemiptera, Odonata, Ephemeroptera, and Coleoptera) constitute the main bulk of food of this group. They occurred abundantly throughout the period of investigation. Dipterous insects

TABLE VI

PERCENTAGE OCCURRENCE OF VARIOUS CATEGORIES OF FOOD IN THE GUTS OF IMMATURE FISHES (*O. punctatus*)

Month	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
No. of fish examined	6	37	45	27	14	11	..	..	..	..	77	101	57	32	16	3	8	4	..
No. of fish with food	6	34	41	23	13	10	..	..	..	..	71	86	50	29	14	3	7	4	..
Food & body wt. ratio	2.41	2.12	2.13	1.76	1.79	1.81	..	..	..	..	2.01	1.95	1.90	1.98	1.56	1.86	1.88	2.01	..
Barbus stigma	16.7	23.5	7.3	4.3	..	..	..	..	..	..	..	5.8	12.0	20.7	7.1	..	14.3	..	..
Esomus danricus	..	2.9	2.4	..	..	..	..	..	..	..	1.4	2.3	..	..	..	..	..	..	..
Diptera	..	20.6	68.3	47.8	61.5	50.0	..	..	..	..	8.4	4.6	10.0	44.8	57.1	100.0	71.4	100.0	..
Hemiptera	50.0	26.5	19.5	17.4	15.4	40.0	..	..	..	..	21.1	22.0	16.0	10.3	14.3	33.3	28.6	25.0	..
Odonata	..	11·8	31.7	26.1	38.5	20.0	..	..	..	..	..	..	2.0	20.7	28.6	33.3	14.3	25.0	..
Coleoptera	..	8.8	9.7	4.3	..	..	..	..	..	..	7.0	9.3	2.0	6.9	..	..	..	..	..
Ephemeroptera	16.7	8.8	4.9	..	..	10.0	..	..	..	..	7.0	3.5	8.0	3.4	7.1	..	14.3	..	..
Hymenoptera	..	..	..	..	..	..	..	..	..	..	1.4	..	..	..	..	..	..	..	..
Digested insects	16.7	17.6	2.4	8.7	..	..	..	..	..	..	2.8	3.5	2.0	..	..	..	14.3	..	..
Copepods	16.7	5.9	14.6	39.1	23.1	10.0	..	..	..	..	81.7	70.9	68.0	44.8	14.3	..	14.3	..	..
Daphnids	..	2.9	14.6	21.7	23.1	10.0	..	..	..	..	62.0	44.2	40.0	34.5	14.3	..	14.3	..	..
Crustacean larvae	..	..	..	..	..	..	..	..	..	..	..	1.2	16.0	16.0	17.2	..	..	..	..
Rotifers	..	..	..	..	..	..	..	..	..	..	14.1	13.9	12.0	6.9	..	..	..	..	..
Gastropoda	..	..	7.3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Algae	..	..	..	8.7	7.7	10.0	..	..	..	..	..	1.2	2.0	..	7.1	..	..	..	..
Higher aquatic plants	..	..	2.4	..	..	..	..	..	..	..	1.4	..	..	..	..	..	..	..	..

included chironomid larvae and pupae. They were rarely seen in the guts of large-sized fishes. Here they were present in nearly 50% guts. In January, February, and March practically all the guts had chironomid larvae and in some fishes as many as 100 larvae were recorded. Chironomid pupae were seldom seen in the guts and mosquito larvae were scarcely present. In this size group, water bugs (*Corixa*, *Notonecta*, and their nymphs) were relatively more abundant and so was the occurrence of dragonfly nymphs. These nymphs as they are eaten by the larger fishes measuring 7 cm. and above were more frequently seen during winter months. May-fly nymphs (Ephemeroptera) which were not found in older fishes were of common occurrence in this group. Similarly copepods (mostly cyclops) and daphnids were never recorded from the guts of older fishes. They were abundantly seen in the guts of smaller fishes particularly from August to October. Many guts of smaller fishes were full of cyclops and their number in one gut was more than 500.

Rotifers were recorded only from fishes measuring 4.5 cm. and below and were found from August to November. Crustacean larvae (nauplii) were found in the months of September, October, and November and constituted 2.4% of the total food.

Organisms of lesser importance were coleopterous insects and algae. One fish measuring 9.6 cm. contained a yellow wasp (Hymenoptera).

From the various categories of food eaten by this size range it appears that smaller fishes are also surface feeders. Excepting chironomid larvae which are bottom dwellers, most of the other organisms ingested live at or near the surface. Probably feeding on chironomid larvae occurs in shallow waters.

(*c*) *Food of the Larvae*

An analysis of the gut contents of 40 larvae has been given in an earlier communication (Qayyum & Qasim 1962). This indicated that the food of the young fishes consists of planktonic organisms such as cyclops, daphnids, rotifers, etc. This has been further confirmed by an analysis of the guts of 22 more larvae in the month of July. This has been given in Table VII.

TABLE VII

PERCENTAGE OCCURRENCE OF FOOD IN THE GUTS OF LARVAL FISHES (*O. punctatus*)

No. of fish examined	22
Size range	7 mm. to 10 mm.
Copepods	100.0 per cent.
Daphnids	13.6 per cent.
Crustacean larvae	31.8 per cent.
Invertebrate eggs	13.6 per cent.
Rotifers	22.7 per cent.

(*d*) *Seasonal Variation in the rate of feeding*

Seasonal variation in the rate of feeding was determined by the weight method previously used by Qasim (1957a, 1957b) and others. After

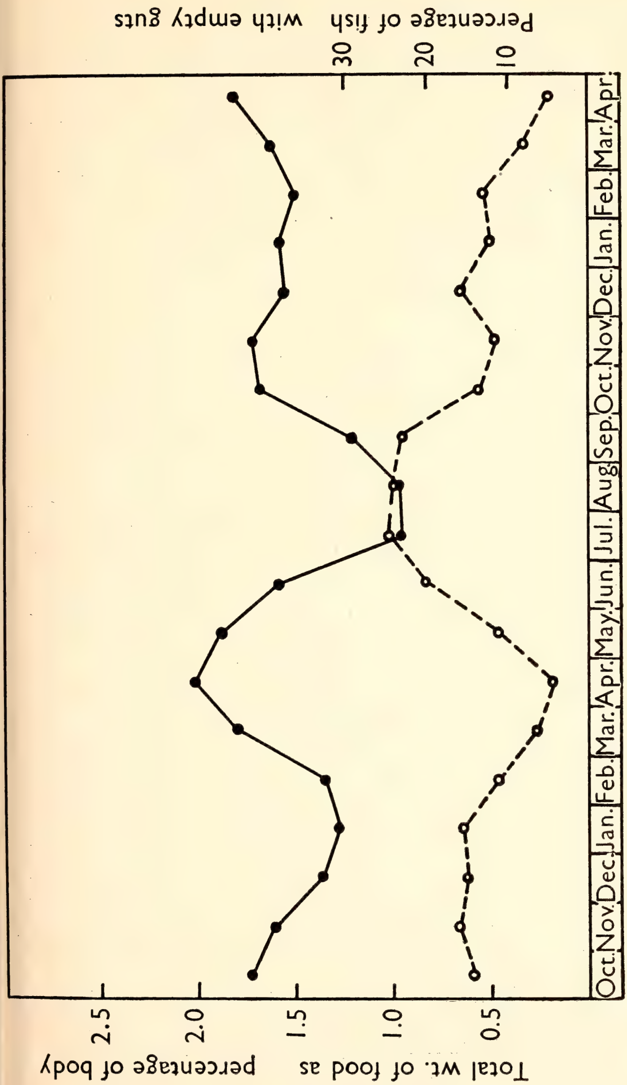

FIG. 8. Seasonal variation in the rate of feeding of *O. punctatus*

Total weight of food of adolescent and older fishes as percentage of body weight, continuous line. Percentage of empty guts, broken line

the qualitative analysis of food was over, the gut contents of all the fishes of a particular size range were mixed together, the excess of water was removed, and the total quantity of food was weighed accurately. This was expressed as the percentage of the total body weight of fish examined. A record of the empty guts was also maintained in each month.

The values obtained in various months have been illustrated in Fig. 8 together with the percentage of empty guts in each month. There were notable variations in the rate of feeding in different seasons. Two periods of intensive feeding were obtained in a year. The first was during the pre-monsoon months (March-June). Presumably a high rate of feeding during this period is required for the building up of gonads and the next phase, as it occurs after the spawning season (October and November), is utilised for the recovery of the fish from the spawning and for building up winter reserves. Feeding is minimal during the breeding season (July and August) when most of the fishes have ripe gonads. Again a cessation of feeding activity occurs during winter months (December-February) when there is a possible decline in the availability of food or perhaps the fish becomes less active in hunting its prey due to prevailing low temperature conditions.

The rate of feeding of smaller fishes (immature) shows a different picture. From the data given in Table VII it appears that in December and January there is a slight decrease in the rate of feeding while in other months there is hardly any variation in the quantity of food consumed.

(*e*) *Concluding Remarks on Food*

From the analysis of food of various size groups it can be concluded that the food of *O. punctatus* throughout its life is as follows : Newly hatched larvae feed on small planktonic organisms such as copepods (cyclops), rotifers, and crustacean larvae. As the larvae grow a little bigger they begin to eat other organisms also, such as daphnids and insect larvae. Small metamorphosed fishes continue to feed on planktonic crustaceans until they reach 5 cm. in length. However, with the increase in size there is a proportionate reduction of planktonic crustaceans until in small fishes measuring 6.5 cm. and above, these organisms become almost negligible in quantity. Such fishes change to larger organisms such as insects and their larvae. Medium-sized fishes measuring 6 cm. to 9 cm. have the main bulk of food made up of insects and other invertebrate organisms. Fishes measuring 9 cm. and more begin to feed on fishes, and finally in the largest-size groups fish becomes a major food item.

To sum up, it seems that *O. punctatus* remains a carnivorous fish throughout life, feeding mainly on invertebrate fauna. Its predation on other forage fishes is a feature acquired later in life.

(*To be continued*)

The BNHS/WHO Bird Migration Study Project—4

Activities from 13-9-1963 to 23-3-1964

BY

SÁLIM ALI

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[*Continued from Vol.* **60** (2): 414]

Three field camps were conducted during the year 1963-64 migration season: (1) at Hingolgadh, Saurashtra, 13-22 September, (2) at Bharatpur, Rajasthan, 21 September to 13 October, (3) at Edanad, Kerala, 26 November 1963 to 5 February 1964; and Mr. P. V. George made an exploratory visit to Bihar extending from 31 January to 23 March 1964.

1. HINGOLGADH, SAURASHTRA: 13-22 SEPTEMBER 1963

The physiography of the netting area is described in the report for spring 1960 [*J. Bombay nat. Hist. Soc.* **59** (1): 111]. Yuvraj Shivrajkumar of Jasdan was again in charge of the activities here. In the 10 days' netting 153 migratory and 67 non-migratory birds were ringed, belonging to 23 and 20 species respectively. The main purpose was to further substantiate the previous finding that individual migrants tend to return to the same wintering areas year after year. Confirmation was amply provided by the interesting recapture on 14-9-1963 of an Orphean Warbler (*Sylvia hortensis*) ringed in almost the identical netting site exactly three years before—on 13-9-1960. Two other individuals of the same species ringed during the previous autumn (24 and 25 September 1962) were also recaptured in the same place on 20 and 21 September 1963. These instances, together with the two similar recaptures detailed on pages 927 and 963 of Vol. **59** (3) of the *Journal* are fairly conclusive evidence that this species returns year after year to the same winter quarters, or at least follows a very restricted route to wherever its ultimate winter destination in India may lie.

2. BHARATPUR, RAJASTHAN: 21 SEPTEMBER TO 13 OCTOBER 1963

Evidence of similar parochiality in the case of resident birds was provided by a Goldenbacked Woodpecker, *Dinopium benghalense*, caught and ringed near Shanti Kutir Forest Rest House on 16-9-1961

and recaptured on 22-9-1963, i.e. 2 years later, in the selfsame acre or two.

The netting in Bharatpur was done by a field party of the BNHS, chiefly in the wagtail roosting area of sugarcane cultivation described in *J. Bombay nat. Hist. Soc.* **59** (3): 927. Even though a vast expanse of flooded sugarcane fields was available for roosting, only certain portions of it were patronized by the birds. Some of these were shared with Red-headed Buntings (*Emberiza bruniceps*), Sparrows (*Passer domesticus indicus* and *P. d. parkini*), Weaver Birds (*Ploceus philippinus* and *P. benghalensis*), and Swallows (*Hirundo rustica*). At such mixed roosts the order of arrival was noted as follows: first Buntings, Sparrows, and Weaver Birds a few minutes before sunset; then Wagtails, dropping in till 15 minutes or so after sunset; followed, lastly, by swallows when almost dark. Thus, for catching all the species at such mixed roosts it was necessary to work the nets differentially, i.e. open them for swallows only after the buntings and wagtails had more or less settled for the night. Otherwise, the nets got so full and sagging with the earlier arriving species that the swallows just bounced back from them without getting 'bagged'. During the 20 days of actual netting in Bharatpur a total of 2782 migratory birds were ringed (list below). Three days were lost in exploring the possibilities of netting wading birds, of which enormous quantities—especially Ruff and Reeve (*Philomachus pugnax*)—had made their appearance by the third week of September. They were feeding in vast tantalizing congregations on the freshly-drained squelchy marshland above Ajan Bund. Apparently, however, our technique was all wrong; the effort proved disappointing and after three days of unsuccess work was reverted to the wagtails.

TABLE I

LIST OF MIGRANTS (10 AND ABOVE) RINGED BETWEEN 13 SEPTEMBER AND 13 OCTOBER 1963

Species	Hingolgadh	Bharatpur
Tringa glareola ..	—	11
Riparia riparia diluta ..	—	10
Hirundo rustica ..	—	220
Muscicapa striata ..	19	—
Sylvia communis ..	60	—
Sylvia curruca ..	10	—
Erithacus svecicus ..	—	36
Motacilla flava beema ..	—	609
——— *thunbergi* ..	—	138
——— ssp. ..	—	1057
——— *citreola* ..	—	201
——— *citreola* (?) ..	—	22
——— *alba personata* ..	—	36
Passer domesticus parkini .	—	30
Carpodacus erythrinus ..	—	14
Emberiza bruniceps ..	—	227

TABLE II

BIRDS EXAMINED AT BHARATPUR AND HINGOLGADH FOR TICKS, AND THE RESULTS

Species	Total examined	No. positive	Species of Tick
Mirafra erythroptera ..	?	1	*Hyalomma marginatus isaaci* (nymphs)
Hirundo fluvicola ..	123	3	*Ornithodoros* sp. (larvae)
Sturnus roseus ..	6	3	*H. m. isaaci* (nymphs) & *Haemaphysalis kutchensis* (nymphs)
Pycnonotus cafer ..	?	2	*H. kutchensis* (nymphs)
Muscicapa striata ..	19	1	(no report)
Sylvia communis ..	60	1	*H. kutchensis* (larvae)
Phoenicurus ochruros ..	3	1	*H. m. isaaci* (nymphs) & *H. kutchensis* (nymphs)
Erithacus svecicus ..	35	1	*H. m. issaci* (larvae)
Saxicoloides fulicata ..	?	7	*H. kutchensis* (larvae and nymphs)
Motacilla flava ssp. ..	987	7	*H. m. isaaci* (larva & nymph), *Hyalomma* sp. ? (nymphs) & *H. kutchensis* (larvae & nymphs)
——— —— *beema* ..	571	9	*H. m. isaaci* (larva & nymph), *Hyalomma* sp. ? (nymphs) & *H. kutchensis* (nymphs)
——— *citreola* (?) ..	?	1	*H. m. isaaci* (nymph)
——— *alba* ssp. ..	3	1	do.
——— —— *dukhunensis* ..	6	1	do.

Ticks

At Hingolgadh ticks were obtained from 16 of the 219 migratory as well as resident birds examined (*c.* 7.3%); in Bharatpur only 20 from 1813 (*c.* 1.1%) migrants. Of the 215 resident birds (22 species) examined in Bharatpur 3 *Hirundo fluvicola* were found positive for ticks. A list of birds examined, and the results, are given in Table II.

The larvae taken from a cliff swallow, *Hirundo fluvicola*, in Bharatpur [Mar./Apr. 1963—*J. Bombay nat. Hist. Soc.* **60** (2): 413] have been identified as those of the tick *Ornithodoros* sp.

Blood Samples

In addition to tick collection, blood samples from about 250 birds of the following species were taken on filter paper discs for antibody studies in the U.S.S.R. This was in response to the suggestions received from Prof. G. I. Netzky, following his visit to the Bharatpur field camp in September 1962 at WHO's invitation in order to devise methods for profitable coordination of our project activities with virological studies in Russian laboratories. Prof. Levkovitch's comments on the collection are awaited with interest.

Species bled: *Motacilla flava beema, M. f. thunbergi, M. f. melanogrisea, M. citreola, M. alba dukhunensis, M. a. personata, Hirundo rustica, Emberiza bruniceps, Erithacus svecicus, Passer domesticus parkini, Riparia diluta.*

Unfortunately it has not been possible as yet to make a proper beginning with Rosy Pastors or wading birds, but it is hoped to start ringing wagtails, swallows, and other reedbed-roosting species in the Calcutta Salt Lake area during the current season with the assistance of local volunteers.

3. The Edanad Wagtail Roost, Kerala: 26 November 1963 to 5 February 1964

In November and the early half of December wagtail concentration at Edanad was as big as those in previous years. The rotation of crops had brought about a change of layout, with crops of sweet potatoes where sugarcane had been and vice versa, but the volume of sugarcane grown on the island remained more or less the same. Till January 6th the sugarcane fields in Edanad were the netting sites. Towards the last quarter of December the number of wagtails roosting at Edanad dropped considerably and from January 7th the team switched

over to a new roost at Mangalam, a village near Chengannur. Situated about a mile west of Edanad, and across the northern channel of Pumba, Mangalam has fewer sugarcane plantations than Edanad, but the wagtails here suffer less disturbance from man and animals. The number of wagtails roosting at Mangalam remained fairly constant throughout. Netting was very effective in the first five days, with an average catch of about 30 birds per net. From January 11th, the catch per net at Mangalam decreased appreciably, while the wagtail population at Edanad again began to increase. From that day to the end of camp (5 February), the team worked in two units (at both Edanad and Mangalam) netting on an average about 275 birds in the morning and about 150 in the evening sessions.

Ringing and releasing

In the morning sessions birds were ringed and released from the compound of the Mar Thoma Church, Edanad. Birds of the evening sessions were ringed at the camp and released immediately into sugarcane fields near the church, choosing fields of larger area so as to avoid overcrowding.

The collection

The two races of the Yellow Wagtail, viz. the Blueheaded (*beema*) and the Greyheaded (*thunbergi*), were most abundant and made up 60.78 per cent of the number ringed this season. Compared with the collection of the last two seasons, the increase in the catch of Forest Wagtails (5.59% of this season's catch) and Yellowheaded Wagtails, *M. citreola*, (7.86% of this season's catch) is noteworthy. As in the previous year, about a hundred white wagtails had an exclusive roost of their own, in sugarcane near the Mar Thoma Church, Edanad. This season 69 birds of this species were ringed, and 7 of the 29 white wagtails ringed in the same spot last year were recaptured. Swallows sharing the roost with wagtails was a novel feature for Edanad, not seen before.

In 64 days of netting (from 26th November 1963 to 5th February 1964) 21,881 wagtails and 39 swallows were ringed making up an aggregate of 21,920 birds for the season.

The total of the wagtails is broken up as follows :

TABLE III

WAGTAILS RINGED AT EDANAD, EXAMINED FOR TICKS, AND THE RESULTS

Species	No. ringed	No. examined for parasites	No. positive	Species of tick
Motacilla indica ..	1224	1216	nil	—
Motacilla flava thunbergi ..	7377	7300	8	*Hyalomma marginatus isaaci* (3 nymphs, 3♂, 2♀)
——— —— *beema*	5927	5891	2	do. (1♂, 1♀)
——— —— *melanogrisea* ..	23	23	nil	—
——— —— *simillima* ?	240	240	nil	—
——— —— ssp. ..	5296	5242	1	*Hyalomma marginatus isaaci* (gynandromorph)
——— *citreola* ..	1722	1707	nil	—
——— *caspica* ..	3	3	nil	—
——— *alba dukhunensis* ..	69	69	nil	—
Total ..	21,881	21,691	11	

The 37 swallows (*Hirundo rustica*) examined were completely free from ticks.

Recaptures of ringed birds

In all, 441 wagtails which had been previously ringed by us were recaptured at Edanad and Mangalam. All but two of them were birds ringed in Kerala and in the following proportion :

TABLE IV

YEARWISE DETAILS OF RECAPTURED WAGTAILS

Year of ringing	Total no. ringed	Total no. of recaptures between 26-11-63 and 5-2-64
1961 Nov.-1962 Jan. ..	1900	8
1962 March ..	4066	25
1962 Dec.-1963 Feb. ..	20,369	158
1963 Nov.-1964 Feb. ..	21,881	250

Besides the above, two wagtails ringed by us elsewhere in India were recovered with the Kerala birds. Their particulars are as follows:

(1) A-38994 *Motacilla flava ? thunbergi* ringed 27-5-1963 in 24 Parganas Dist., W. Bengal, recovered at Edanad on 29-11-1963.

(2) A-15897 *Motacilla citreola ?* ringed 4-10-1962 at Bharatpur, Rajasthan, recovered at Mangalam on 13-1-1964.

These recoveries along with the previously reported ones from Kazakhstan, Afghanistan, and NW. Pakistan constitute important sign-posts in the general pattern of wagtail migration in India.

Examination for external parasites

Ninety-nine per cent. of the birds ringed this season were examined for external parasites, and 11 ticks were collected up to 7th January, but none after this date in spite of a more thorough search.

Collection of blood samples

446 ringed birds which could be identified subspecifically with certainty were bled for samples for virological investigation by Kievskae Shosee Institute of Poliomyelitis and Virus Encephalitis, Moscow. Blood was drawn from incisions made near the base of the claws without any crippling injury to the birds.

Acknowledgements

Our thanks are due to Messrs. Oomen, Thomas, Vasu Pillai, Ramachandran Pillai, Ramachandran Panikkar, and Kochukuttan, who assisted the field party, and to the Trustees of the M.T. Church, Edanad, for permission to use the churchyard for our ringing activities.

4. North Bihar: 31 January to 23 March 1964

Mr. P. V. George visited Bihar to explore the possibilities of extending the Project activities to that area, particularly to waders (Charadriiformes) and ducks. He surveyed the area from the Ganges up to the India-Nepal border of central northern Bihar. His interesting report will be published separately.

With the help of local trappers Mr. George was able to ring nine hundred and four birds of the following twentyfive species:

TABLE V

BIRDS RINGED IN MANJHAUL (MONGHYR DIST.)

Anas crecca	..	..	239
Anas querquedula	..	..	19
Anas clypeata	..	..	9
Nettapus coromandelianus	..	..	1
Pluvialis dominica	..	..	11
Charadrius dubius	..	..	1
Charadrius mongolus	..	..	3
Tringa glareola	..	..	90
Tringa totanus	..	..	1
Tringa ochropus	..	..	2
Capella stenura	..	..	11
Capella gallinago	..	..	82
Capella minima	..	..	3
Calidris minutus	..	..	25
Calidris temminckii	..	..	27
Philomachus pugnax	..	.	1
Rostratula benghalensis	..	..	2
Himantopus himantopus	..	..	3
Jynx torquilla	..	..	1
Calandrella cinerea	..	..	303
Erithacus svecicus	..	..	9
Saxicola torquata		..	2
Motacilla flava	..	..	15
Motacilla citreola	..	..	35
Motacilla alba	..	..	9

Recovery of a ringed Teal

An interesting recovery at Srinagar, Kashmir, on 15 March 1964 of a Teal (*Anas crecca*) ringed by him in Manjhaul (6-2-1964) suggests a rather unusual direction of flight.

Collection of blood samples

Blood samples were collected from *Anas crecca, A. querquedula, A. clypeata, Aythya ferina, Tringa glareola, Capella gallinago, Fulica atra,* and *Calandrella cinerea* for virological examination by Kievskae Shosee Institute of Poliomyelitis and Virus Encephalitis, Moscow.

Possibilities of ringing in north Bihar

North Bihar seems to offer excellent possibilities for bird migration studies. Ringing at the beginning of winter and subsequent recoveries in other parts of the country may provide information on the dispersal of birds within India.

For waders and ducks the best time would appear to be from mid-November to the middle of January. 'Daylight roosting' places of these birds should also afford chances of large scale netting. For large scale ringing of Short-toed Larks the best time is reportedly March and April. It is hoped to exploit these opportunities in the winter of 1964-65.

Acknowledgements

We are indebted to Mr. T. P. Singh, Development Commissioner, Bihar, Mr. S. S. Sharan, District Magistrate of Monghyr, and Mr. U. K. Prasad, S.D.O., Waterways, Manjhaul, for facilities and assistance rendered to Mr. George during his survey.

Two New Species of Marine Borers of Genus *Nausitora* (Mollusca : Teredinidae) from West Bengal, India

BY

A. S. Rajagopal

Zoological Survey of India, Calcutta-12

(*With two text-figures and one plate*)

Introduction

This paper forms the second part of the study of the collections made of marine molluscan borers from Port Canning and Sajnakhali, Sundarbans, West Bengal, in 1958 and 1961 and in the Hooghly river, Calcutta, in 1961. In an earlier paper (A. S. Rajagopalaiengar 1961), a new species of borer, namely *Bankia* (*Neobankia*) *roonwali*, was described.

About 140 specimens of various sizes were collected around Sajnakhali, Sundarbans, from different kinds of living mangrove trees, the names of which are given below (the last named was not in living condition):

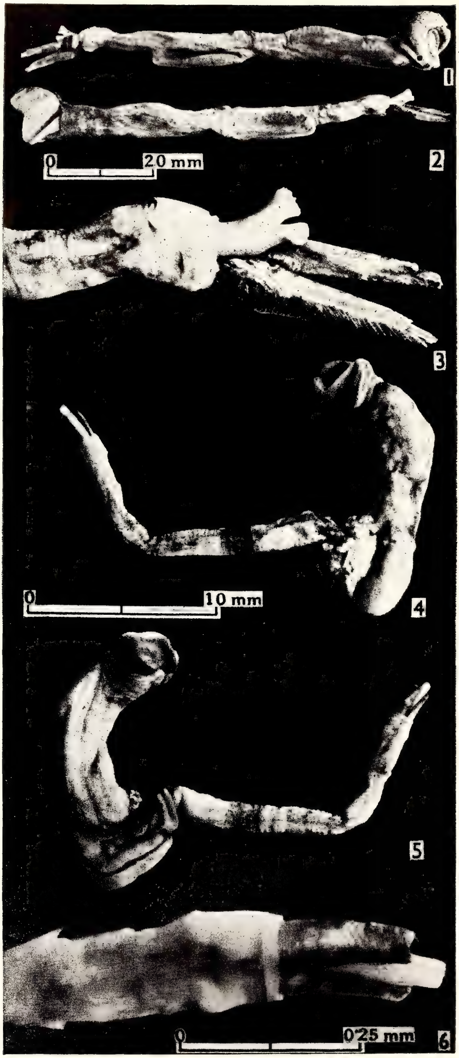
Bengali name	*Botanical name*	*Family*
1. 'Gengwa'	*Excoecaria agallocha* Linnaeus	Euphorbiaceae
2. 'Goran'	*Ceriops decandra* (Roxb.) (= *C. roxburghiana* Arn.) *Ceriops tagal* (Perry) C. B. Robins (= *C. candolleana* Arn.)	Rhizophoraceae
3. 'Khalsi'	*Aegiceras corniculatum* Blanco	Myrsinaceae
4. 'Sundari'	*Heritiera fomes* Buchanan-Hamilton	Sterculiaceae
5. 'Pussur'	*Xylocarpus molluccensis* Roemer (= *Carapa molluccensis* Lamarck)	Meliaceae

Systematic Account

Genus *Nausitora*

This genus has as many as 20 species described from different parts of the world.

Two new species are described here. In describing the shell parts, the terminology used by Clench & Turner (1946) is largely followed.



Nausitora lanceolata sp. nov. : 1-2. Right and left lateral views of entire animal (Holotype) ; 3. Enlarged left lateral view of posterior region of Holotype, showing siphons and pallets.

Nausitora sajnakhaliensis sp. nov : 4-5. Right and left lateral views of entire animal (Holotype) ; 6. Enlarged left lateral view of posterior region of Holotype, showing siphons and pallets.

Note. Figs. 1 and 2 on same scale ; Figs. 3, 4, and 5 on same scale.

Nausitora lanceolata sp. nov.

(Text-fig. 1; Pl., figs. 1-3; Table)

MATERIAL

LOT A. (i) Coll. *A. S. Rajagopalaiengar*, 4 examples, Edge of Matlah R. at low tide, Port Canning, 24-Parganas, 12.i.1958, *ex* a trunk of a dead tree.

LOT B. Coll. *H. C. Ray*, Sajnakhali, lat. 28° 7′ N., long. 88° 50′ E., 24-Parganas, as follows:

(ii) 11 examples, Tetulbaria Camp, *c.* 17 km. SW. of Forest Office, 26.iii.1958, *ex* pieces of living mangrove tree.

(iii) 1 example, S. bank of Sajnakhali Khal, E. of Forest Office, 28.iii.1958, *ex* a piece of living mangrove tree.

LOT C. Coll. *A. S. Rajagopalaiengar*, Sajnakhali, lat. 28° 7′ N., long. 88° 50′ E., 24-Parganas, April-May 1961, as follows:

(iv) 11 examples, Baentolla-Bharani, a creek *c.* 1 km. W. of Forest Office, 26.iv.1961, *ex* a piece of 'Sundari' tree.

(v) 1 example, Baentolla-Bharani, a creek *c.* 1 km. W. of Forest Office, 27.iv.1961, *ex* a piece of 'Gengwa' tree.

(vi) 15 examples, Baentolla-Bharani, a creek *c.* 1 km. W. of Forest Office, 27.iv.1961, *ex* a piece of 'Sundari' tree.

(vii) 9 examples, on bank of Gomdi R. *c.* 5 km. W. of Forest Office, 30.iv.1961, *ex* a piece of 'Goran' tree.

(viii) 5 examples, bank of Gomdi R. *c.* 5 km. W. of Forest Office, 30.iv.1961, *ex* a piece of 'Khalsi' tree.

(ix) 1 example, Pichkhali *c.* 6 km. E. of Forest Office, 1.v.1961, *ex* a piece of 'Gengwa' tree.

(x) 7 examples, Pichkhali *c.* 6 km. E. of Forest Office, 1.v.1961, *ex* a piece of 'Goran' tree.

(xi) 4 examples, bank of Gomdi R. *c.* 5 km. W. of Forest Office, 1.v.1961, *ex* a piece of 'Khalsi' tree.

(xii) 5 examples, Sajnakhali Forest Office jetty, 1.v.1961, *ex* a piece of 'Pussur' wood.

(xiii) 5 examples, Sudhanyakhali *c.* 13 km. S. of Forest Office, 2.v.1961, *ex* a piece of 'Goran' tree.

(xiv) 11 examples, Sajnakhali Forest Office jetty, 2.v.1961, *ex* a piece of 'Pussur' wood.

(xv) 35 examples, Sudhanyakhali *c.* 13 km. S. of Forest Office, 2.v.1961, *ex* a piece of 'Sundari' tree.

(xvi) 11 examples, Sudhanyakhali *c.* 13 km. S. of Forest Office, 3.v.1961, *ex* a piece of 'Goran' tree.

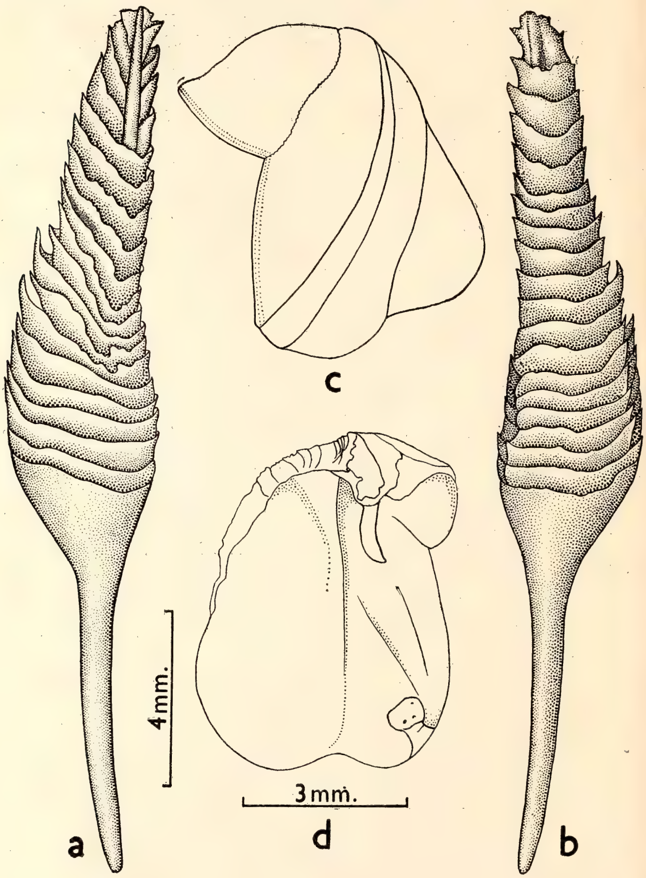
(xvii) 1 example, Sajnakhali Forest Office jetty, 3.v.1961, *ex* a piece of 'Pussur' wood.

LOT D. (xviii) 1 example, King George's Dock, Calcutta, 21.iii.1950, donated by the Commissioners for the Port of Calcutta, *ex* a submerged timber.

LOT E. (xix) Coll. *A. Daniel*, *G. Ramakrishna*, and *A. S. Rajagopalaiengar*, 100 examples, Bull's nose jetty, Kidderpore Docks, Calcutta, 28.xii.1961, *ex* an experimental panel.

DESCRIPTION

1. *Shell* (Text-fig. 1, c-d ; Pl., figs. 1-2 ; Table). Globular, white or pinkish mainly according to colour of wood infested, fairly thick. Dorsal nondenticulated area of anterior lobe marked by usual sinus. From here radiate equidistant ridges on the surface of lobe



Text-fig. 1. *Nausitora lanceolata* sp. nov.

a-b. Outer and inner views of the entire pallet ; *c-d.* Outer and inner views of the shell

denticulated at their free margins. Number of ridges 20 to 34, ridges wide apart in younger stages, more closely set in adults. Height of lobe almost equal to its length. An impressed wavy line demarcating anterior lobe from disc. Anterior portion of disc with denticulated ridges 15 to 45 in number present on its surface. Ventral margin of lobe meeting anterior margin of disc at right angles. Rows of teeth on lobe also meeting those on anterior portion of disc at right angles but not continuous. Anterior portion of disc quite broad, width about two-thirds of anterior lobe. Median portion of disc long, narrow, tinged deepest pink, extending from umbone to ventral condyle slightly wider near ventral region without denticles but possessing irregular lines of growth. Posterior portion of disc smooth, white, narrow, and extending to auricle. Auricle, conspicuous in younger stages, getting reduced to a small remnant in adults, embedded in mantle of living specimens.

Internally, shell smooth and white. A line indicating junction of anterior lobe with anterior portion of disc visible. Median portion of disc appearing as a groove. Umbonal region with a prominent condyle and apophysis springing below it and projecting downwards. Apophysis short, narrow, extending obliquely to about a third of distance to ventral edge. A strong condyle present at ventral edge of shell. Upper margin of posterior portion of disc appearing somewhat eroded. Auricle having translucent incremental lines within it. Shelf arising from below dorsal condyle at a place slightly posterior to it and extending downwards, narrow, clearly visible about half way in shell but gradually merging beyond it with the shell surface.

2. *Pallets* (Text-fig. 1, *a-b*; Pl., fig. 3; Table). Long, solid calcareous structure with a stalk and a blade. Stalk short, straight, cylindrical with a pointed tip; continuous up to some extent but not fully inside blade. Blade long, slightly inequilateral, resembling the head of a spear, and consisting of fused cone-like structures with convex outer and slightly concave inner surfaces, expanded proximally and narrowing distally. Proximal region of blade invariably covered by a light or dark brown periostracum appearing like compressed transverse imbrications. In younger stages these imbrications ending in slender processes at lateral borders. Rest of blade gradually tapering, its outer surface with a series of shelly imbrications of fused V-shaped structures (distinct in younger stages), with one arm of V longer than the other; the condition being reversed in the other pallet. V-shaped structures present till end of blade but becoming progressively acute distally. Both lateral margins serrated or crenulated, serrations sharper along margin with shorter limbs of V. Outer surface of blade usually eroded linearly along middle line from tip towards base to a variable extent (as in holotype) due probably to frequent rubbing with inside of

calcareous tube enclosing it, during animal's to-and-fro movements of its posterior end. Distal part of blade glassy and somewhat transparent.

Inner surface of blade consisting proximally of a series of transverse wavy laminae, disappearing gradually distally. Both lateral borders serrated, serrations wearing out in older forms. Blade definitely ending in more or less pointed tip in well-preserved pallets.

3. *Siphons* (Pl., fig. 3). Short, conjoined, equal in length, bifid subterminally, and mottled with a few brown spots. Inhalant siphon with wider opening than exhalant. Tiny papillate projections present at the tip of inhalant siphon.

4. *Collar.* A well-developed collar present at the base of siphons.

5. *Burrow.* A thick calcareous tube secreted by the mantle enclosing the animal but non-adhering to it except at collar region. Burrow thicker and harder posteriorly at region of siphons and pallets.

TYPE-SPECIMENS

All type specimens deposited in the National Zoological Collection, Zoological Survey of India, Calcutta. *Holotype*: One example from Material LOT C (xv) above, Z.S.I. Reg. No. M. $\frac{16841}{2}$ Sajnakhali, coll. A. S. Rajagopalaiengar, 2. v. 1961, *ex* a piece of 'Sundari' tree.

Paratypes: Four, as follows: One each from Material LOT C (iv), (xii), (xv), and (xvi) above, Z.S.I. Reg. No. M. $\frac{16842}{2}$ to M. $\frac{16845}{2}$.

TYPE LOCALITY

INDIA: West Bengal: Sajnakhali (24-Parganas District), about 13 km. south of the Sajnakhali Forest Office, lat. 22° 7′N., long. 88° 50′ E.

GEOGRAPHICAL DISTRIBUTION

INDIA: West Bengal: (Calcutta District), King George's Dock, Kidderpore Dock, Port Canning, Sajnakhali and its vicinity.

COMPARISON

In possessing a broad anterior portion of disc in the shell, *Nausitora lanceolata* resembles *N. braziliensis* Bartsch. In the condition of smallness of the auricle in the shell it approaches the condition in *excolpa* Bartsch, *dryas* (Dall), *braziliensis* Bartsch, *smithi* Bartsch, *hedleyi*

Schepman, and *madrasensis* Nair. In this very condition it is dissimilar to *dunlopei* Wright and *gabrieli* Nair in which cases an auricle is altogether lacking in the shell. In the eroded condition of posterior margin of the shell it is similar to *gabrieli* Nair.

In the general shape, the pallet of *lanceolata* reminds one of the head of a spear. Hence, the name *lanceolata* proposed. Although superficially, the pallet of *lanceolata* may appear to bear some resemblance to that of *dunlopei* Wright, *hedleyi* Schepman, *messeli* Iredale, and *queenslandica* Iredale, it seems to be more akin to *hedleyi* than to the others. It, however, differs markedly from *hedleyi* in the following respects :

(1) In size the pallet of *lanceolata* is much larger than that of *hedleyi*,

(2) In the blade the distal portion of which is usually not covered by periostracum a series of V-shaped imbrications are present in *lanceolata*, whereas oblique ridges divided into two parts by a narrow median ridge are found in the corresponding place in *hedleyi*, and

(3) A median groove caused by erosion or friction occurs on the outer surface of the blade in many cases in *lanceolata*, while a characteristic ridge occupies the corresponding place in *hedleyi*.

In the presence of a central core-like body inside the blade, *lanceolata* is similar to *dunlopei*, but it is unlike the latter in the following:

(1) In *lanceolata* an auricle, even though in some cases quite reduced in size, is present in the shell, while it is absent in that of *dunlopei*,

(2) The pallet of *lanceolata* is much smaller in size than that of *dunlopei*,

(3) While the outer surface of the blade in *lanceolata* bears a series of V-shaped imbrications, that of *dunlopei* is stated to be merely 'roughly imbricated', and

(4) The tip of the blade in *lanceolata* ends somewhat pointedly, whereas in *dunlopei* it is shown in figures to end abruptly.

In having a serrated lateral margin along the blade *lanceolata* is similar to *hedleyi* and *dryas* (Dall).

Nausitora sajnakhaliensis sp. nov.

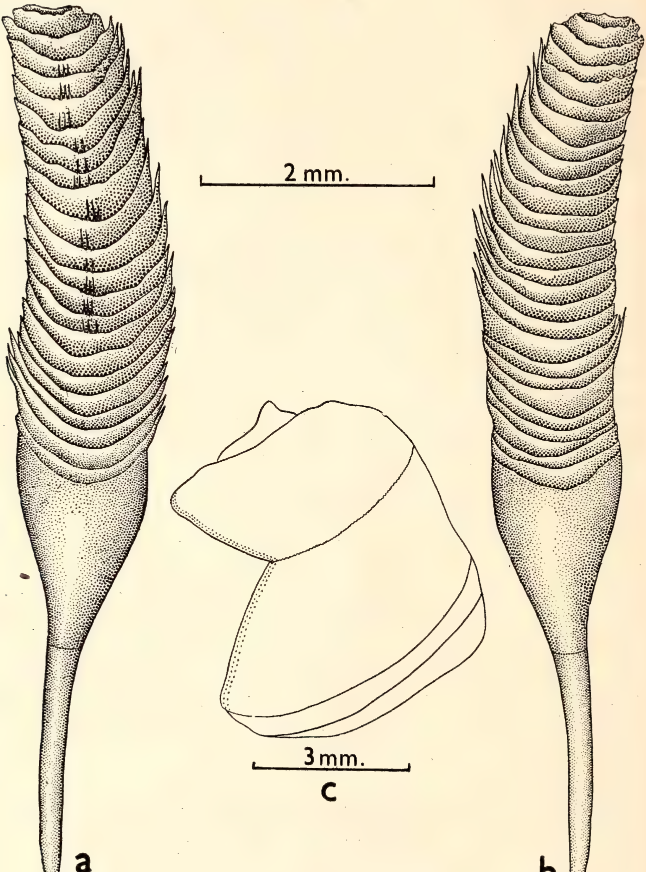
(Text-fig. 2 ; Pl., figs. 4-6 ; Table)

MATERIAL

LOT A. Coll. *A. S. Rajagopalaiengar*, Sajnakhali, lat. 28° 7′ N., long. 88° 50′E., 24-Parganas, 30. iv. 1961 and 3. v. 1961 as follows :

(i) 2 examples, bank of Gomdi R. *c.* 5 km. W. of Forest Office, 30. iv. 1961, *ex* a piece of living 'Goran' tree.

(ii) 1 example, Sudhanyakhali *c.* 13 km. S. of Forest Office, 3. v. 1961, *ex* a piece of living 'Goran' tree.



Text-fig. 2. *Nausitora sajnakhaliensis* sp. nov.

a-b. Outer and inner views of the entire pallet ; *c*. Outer view of the shell (auricle partly embedded in the mantle)

DESCRIPTION

1. *Shell* (Text-fig. 2, c ; Pl., figs. 4-5 ; Table). Globular, pinkish, thin and translucent. Dorsal nondenticulated part of lobe bordering the usual sinus, broad and smooth. From here radiate on surface of lobe closely-set equidistant ridges denticulated at free margins. Space between ridges as wide as ridges, wider in younger stages. Number of ridges 40 to 54. Height of lobe slightly greater than its length. Line marking out anterior lobe from disc impressed, wavy, and usually curved like an arc. Anterior portion of disc also possessing on its surface closely-set denticulated ridges twice as wide as space between them. Number of ridges 30 to 45. Ridges meeting those on lobe at slightly greater than a right angle but not continuous with them. Anterior portion of disc quite broad, width equal to length of anterior lobe. Median portion of disc narrow, extending from umbonal region to ventral condyle, its surface having wavy, irregular lines of growth. Posterior portion of disc narrow in adults but wider in younger stages, smooth, and passing on to auricle. Auricle fairly large and conspicuous in younger stages but getting reduced in adults, usually embedded in mantle in living condition, slightly upturned at outer margin when exposed.

Inner view of shell could not be studied owing to extremely limited stock of material.

2. *Pallets* (Text-fig. 2, *a-b* ; Pl., fig. 6 ; Table). Elongate, whitish, solid, calcareous structure, with a short cylindrical stalk, long blade, slightly curved like a sword, bulged outwardly and flat along inner surface. Blade with a series of transverse obtuse V-shaped imbrications covered completely with transparent or chocolate-coloured membrane. In well-preserved condition transverse free margins of membrane possessing double rows of pectinate processes. Lateral border of imbrications appearing coalesced and ending in slender processes. Distal end of blade with concave depression.

Inner surface of blade with imbrications covered by membrane without pectinate processes along transverse free margins. Imbrications concave but shallower than those on outer surface.

3. *Siphons* (Pl., fig. 6). Conjoined, and bifid only subterminally, inhalant siphon with wider opening than exhalant and possessing short hairy outgrowths or chocolate-coloured tiny spine-like outgrowths on its surface. Exhalant siphon slighly shorter than inhalant.

4. *Collar*. Not prominent, thin, partially concealing siphons and pallets.

5. *Burrow*. Fairly thin and non-adherent to animal except at region of collar.

TYPE-SPECIMENS

All type specimens deposited in the National Zoological Collection, Zoological Survey of India, Calcutta.

Holotype. One example from Material LOT A (ii), above Z.S.I. Reg. No. M. $\frac{16846}{2}$ Sajnakhali, coll. A.S. Rajagopalaiengar, 3.v.1961, *ex* a piece of living ' Goran ' tree.

Paratypes. Two examples from Material LOT A (i) above Z.S.I. Reg. No. M. $\frac{16847}{2}$.

TYPE-LOCALITY

INDIA: West Bengal: Sajnakhali (24-Parganas Dist.), about 13 km. south of the Sajnakhali Forest Office, lat. 22°7′N., long. 88° 50′ E.

GEOGRAPHICAL DISTRIBUTION

INDIA: West Bengal: Sajnakhali and its vicinity (24-Parganas Dist.).

COMPARISONS

In the possession of a broad anterior portion of disc in the shell, *Nausitora sajnakhaliensis* bears some similarity to *N. braziliensis* Bartsch. In the upturned feature of the outer margin of the auricle it resembles the condition in *fusticula* (Jeffreys), but it differs from the latter in having more closely-set dental ridges on the anterior lobe of its shell.

Its pallet has a superficial resemblance to *dunlopei* Wright but in size of pallet it is far smaller than the latter (pallet of *dunlopei* measures about 25 mm. while that of the present species is only 7 mm.). In having a concave depression at the tip of the pallet, it differs from *dunlopei*, but resembles *orientalis* Roch & Moll and *kamiyai* Roch & Moll. In the presence of V-shaped imbrications on the outer surface of blade, it is somewhat similar to *saulii* Wright.

ACKNOWLEDGEMENTS

I am grateful to Dr. M. L. Roonwal, Director, Zoological Survey of India, for his kind and useful criticisms while going through the paper.

TABLE

MEASUREMENTS OF *Nausitora lanceolata* sp. nov. AND *Nausitora sajnakhaliensis* sp. nov.

Body-part	*Nausitora lanceolata*		*Nausitora sajnakhaliensis*	
	Holotype	Range (25 exs.)	Holotype	Range (3 exs.)
	mm.	mm.	mm.	mm.
1. Total length	90.00	22.00-199.00	31.00	31.00-63.00
2. Length of shell	11.50	5.00-11.50	4.00	3.50- 5.00
3. Height of shell	11.00	5.00-11.00	3.50	3.50- 4.50
4. Length of pallet	18.00	7.50-19.50	5.50	5.50- 7.00
5. Length of stalk	6.00	3.00-8.00	2.00	2.00- 3.00
6. Length of blade	12.00	4.00-12.00	3.50	3.50- 4.00
7. Diameter of blade	3.00	1.50-3.50	1.00	1.00- 1.50

Summary

The discovery of two new species under the genus *Nausitora*, namely *Nausitora lanceolata* and *N. sajnakhaliensis*, infesting dead and living mangrove trees of Sundarbans, West Bengal, India, is reported with detailed descriptions of the shell and pallet characters of each species.

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The Lepidoptera of Bahrain

BY

E. P. WILTSHIRE, F.R.E.S.

(*With three plates and one text-figure*)

CONTENTS

INTRODUCTION

Nothing has been published about the Lepidoptera of Bahrain before the present decade. Indeed, it would appear that no insect has been collected on the island before 1959, although its geology, as is natural in an oil-producing state, and its flora (see Good 1954) are better known.

PHYSICAL FEATURES : ARTESIAN WATER-SUPPLY

The name Bahrain applies both to the principal island and to the archipelago. The lepidopterous fauna of the former is the subject of the present study. It is unlikely that the smaller islands contain any species not to be found also on the principal island, which far

exceeds all the others in area, elevation, variety of vegetation, and water supply. Its fauna, however, like that of most islands, though interesting, is restricted and poor.

Bahrain is situated at about Lat. 26° N., Long. 51° E., on the Arabian (south) side of the Persian Gulf, in a bay between the Eastern Province of Saudi Arabia and the peninsula of Qatar. The principal island measures about thirty miles from north to south and about ten miles from west to east at its widest point. The highest point, the Jebel Dokhan in the centre of the island, is only 400 feet above sea-level. The rainfall averages less than three inches annually; all of this falls in the cool season, between November and April. Most of the territory is arid desert but, thanks to artesian water, the northern part contains strips of oasis.

The artesian water-supply of Bahrain deserves further mention, as the island is quite unique in this respect, and the survival of a striking component of the fauna and flora depends on it. Among the Eocene strata of Arabia, sloping gently down to the sump of the Persian Gulf, is a brown crystalline Nummulitic limestone. Rain penetrates this limestone stratum where it outcrops in the high Arabian plateau, mainly in the Dahana. This underground water, owing to impervious strata above and below it, and to a peculiar local undulation, becomes concentrated under pressure over a narrow band, not wider than ten miles from north to south, flowing south-eastwards under the Arabian coast and the north end of Bahrain. The aquiferous stratum then surfaces in the sea-bed between Bahrain and Qatar, and much of the water is lost in the form of freshwater springs at sea, on either side of the north end of the island. In the centre of the island is a dome of Eocene strata; here the same brown limestone, itself capped by resistant chert, is uppermost in Bahrain's principal hill, Jebel Dokhan. Naturally the water-head is incapable of rising to this height but, from the dawn of the Holocene, fresh springs have gushed up in the flatter, northern parts of the island. In one place a stream, several miles long, reaches the sea in a wide estuary, and is probably the only stream in the whole of Arabia to do so on a perennial basis. The estuary shores are overgrown with mangrove bushes (*Avicennia*). Recently many wells have been bored into the aquifer both in northern Bahrain and on the mainland of the Eastern Province of Saudi Arabia. Due to these wells' excessive take-off reducing the underground pressure, the water-head is sinking annually, and saltwater is entering the aquifer at the eastern end. Though much lower than in early days, the water-head is nevertheless still above sea-level in Bahrain. The ancient Arabian oases of Qatif

and Hofuf correspond, on the mainland, to such Bahrain sources as Adari and Kasari.

Thanks to these amenities Bahrain was inhabited in Sumerian times by civilised man and was a prosperous trading entrepôt between the two civilisations of the Sind Valley and Mesopotamia. Over a hundred thousand funeral mounds line the dry slopes on either side of formerly, or still, cultivated land; well-carved stone temples and houses have recently been found in the excavation of the principal city and the numerous settlements of what the Sumerians called Dilmun. The date-palm seems to have been then, as now, the principal cultivated crop.

Supposed emergence from sea : faunistic evidence

As regards rather earlier times, geologists seem to agree that both Bahrain and the adjacent coasts of Arabia have been, and still are, rising gradually from the sea; there is archaeological evidence that in Sumerian times the sea-level was a few feet higher than now, but some geologists go so far as to say that the whole island was formerly submerged and at the best represented by a sea-washed reef. There is certainly a good deal of salt in its soil.

The present vertebrate fauna of the island however could scarcely have inhabited it when it was a mere reef. The presence of gazelle, and even hare, may be due to importation or reimportation by man, but could the same be said of the lizard (*Uromastix*) (Arab. *dhubb*) or the jerboas (*Meriones*)? Their presence suggests that Bahrain was formerly united to the mainland and has never been entirely submerged, to the detriment of its desert fauna, since that union.

Lepidoptera, being capable of flight, shed little light on this problem. No apterous species has been found on the island; but this may not be significant as it is not known whether any apterous species inhabits the adjacent mainland. At Kuwait and Bushire, indeed, two or three species with apterous females (*Chondrostega* and *Ocnogyna*) fly commonly, and their larvae swarm in spring, but they have not yet been noted in the Dhahran-Qatif district, close to Bahrain. It may be that these moths do not reach so far south on account of general ecological conditions unfavourable to them, whether on Bahrain or the mainland.

Good (op. cit.) noted the absence of endemic elements in the desert flora, and it seems unlikely that there are genuinely endemic lepidoptera in Bahrain. Exploration will probably eventually reveal

that the one or two species, which are now known only from the island (e.g. *Cryphia polyphaenoides* Wilts.) inhabit similar habitats in SE. Arabia. It must be remembered that until recently no entomological exploration at all took place in Bahrain, and that conditions in the rest of Arabia are still unfavourable to collection. If however the island's fauna proves to contain one or two true endemics, the theory that Bahrain was once a mere reef in the sea will evidently have to be abandoned and, instead, only a slight reduction in area, due to a slightly higher sea-level, could be accepted in the history of Bahrain. Even if there are no true endemics, the argument of the vertebrate fauna requires to be weighed, when considering the history.

Biotopes : vegetation

Before analysing the elements of the fauna, the biotopes and vegetation should be described. As elsewhere in the arid Middle East, there is a sharp contrast between the oasis and the desert. Each of these main two biotopes has a characteristic flora and fauna. In the list which follows, the less characteristic and also the entomologically uninteresting kinds of plant will be omitted.

(a) *Oasis*

One might well omit the mangrove swamp as being a maritime community. It appears devoid of Lepidoptera except that its fringe is possibly the home of *Cardepia sociabilis*. Except for this swamp, the oasis vegetation is structurally entirely a flora of cultivation. The oasis vegetation is decidedly more tropical than that of the Mesopotamian oasis, even at its southernmost point (studied in Wiltshire 1950). The species absent from S. Iraq in the list below are marked (T). The absence of *Salix* and *Populus* is remarkable, and even *Tamarix* is rare.

Characteristic trees, probably indigenous, are:

Date-palm (*Phoenix dactylifera*) (Arab. *Nakhl*)

Christ-thorn (*Zizyphus spina-christi*) (Arab. *Tebek, Sadr*)

Deciduous mesquite (*Prosopis stephaniana*) (Arab. *Shoq*).

The third of these, though often no more than a shrub, attains a height of 5 metres in some gardens, but is rather more localised than the others.

Other commonly planted trees, probably more recently imported, are:

(T) Evergreen mesquite (*Prosopis spicigera*)

(T) Indian almond (*Terminalia catappa*)

The Lepidoptera of Bahrain

Scene in southern desert

Limestone hills with sand, and pipe-line from oil-well. Vegetation seen is mainly *Leptadenia pyrotechnica* and grasses. Flying place of *Anumeta straminea* etc.

Taverniera spartea in flower

On northern flanks of desert near Ali. Foodplant of *Drasteria yerburyi* etc.

Photos : E. P. Wiltshire

The Lepidoptera of Bahrain

The Kasari washermen's pool

One of the natural sources of Bahrain. On left dense oasis vegetation; right bank converted to dhobi-ghat in Indian style. Flying place of *Mocis frugalis* etc.

Rocky desert hills in southern desert

Showing *Lycium persicum* and *Ochrodenus baccatus* in flower. Locality for *Jordanisca tenuisaria* and *Neromia pulvereisparsa*

Photos : E. P. Wiltshire

(T) Mango (*Mangifera indica*)
(T) Flamboyant (*Delonix regia*)
(T) Tamarind (*Tamarindus indica*)
Casuarina (*Casuarina equisetifolia*)
Tamarisk (*Tamarix articulata*) (Arab. *Ithl*).

Lawn-grass (identity uncertain) is entomologically most important. Garden ornamental shrubs include:

Oleander (*Nerium oleander*) (first imported within living memory)
Jasmine (*Jasminum* sp.).

Citrus trees, recently introduced, do not thrive on Bahrain soil; their presence is welcome to the lepidopterist for the sake of the handsome butterfly *Papilio demoleus* L. The more serious pests of the tree have also, to some extent, arrived in the island.

Commonly planted as a hedge, and perhaps indigenous, is:

(T) *Clerodendron inerme.*

Common oasis plants, doubtless indigenous, are:

Camel-thorn (*Alhagi maurorum*)
Reed (*Phragmites communis*)
Caper (*Capparis spinosa*).

The third of these is more local, but seems to be spreading.

Probably indigenous is the very local shrub:

Pluchea dioscorides.

A dwarf shrub common in oasis and desert alike and almost ubiquitous is:

Zygophyllum album.

The most thriving ground crop in oases is Lucerne or Alfalfa (*Medicago sativa*). Tomato (*Solanum lycopersicum*) and Lettuce (*Lactuca sativa*), with a briefer season, are also grown.

(b) *Desert*

As Good (op. cit.) pointed out, the desert-flora is a widespread Saharan-Sindian type, with many absentees. Here again the less noteworthy and entomologically uninteresting are omitted. Two species of tree are noteworthy but both are very local:

Leptadenia pyrotechnica (only in the southern desert)
Acacia arabica (only at Sakhir, in an alluvial desert-valley).

Localised desert plants of entomological importance are:

Pink desert-broom (*Taverniera spartea*) (Only on alluvial ground on the north and east 'flanks', between Sitra and Ali, where it forms conspicuous bluish green perennial stands; the ground appears here to have been formerly cultivated and even now to have a high

water content, as many of the herbs remain green throughout the summer)

Pennisetum dichotomum and other dune grasses (Only in the southern desert, where blown sand is found close to limestone cliffs. This habitat recalls closely a similar one near the Great Pyramid at Giza, near Cairo, and several characteristic moths inhabit both: e.g. *Scotia sardzeana* Brandt, *Anumeta straminea* B.-H. In summer the vegetation of this habitat appears quite dried up.)

Helianthemum lippii and *H. kahiricum* (common and more widespread than the grasses in the rocky and sandy desert south of Awali)

Ochrodenus baccatus (only on rocky hills, in the southern desert)

Calligonum comosum (only in the southern desert).

Rather more widespread on desert soil, though less so than *Zygophyllum album*, are:

Lycium persicum (a thorny shrub)

Heliotropium tuberculosum (a dwarf shrub).

Representation of Families of Lepidoptera

The number of species in each family is as follows. The numbers in brackets indicate the place in the list of species:

Papilionidae	1 (No. 1)
Pieridae	3 (Nos. 2-4)
Lycaenidae	5 (Nos. 5-9)
Nymphalidae	2 (Nos. 10-11)
Danaidae	1 (No. 12)
Hesperiidae	1 (No. 13)
Lasiocampidae	1 (No. 14)
Sphingidae	4 (Nos. 15-18)
Arctiidae	2 (Nos. 19, 20)
Lymantriidae	1 (No. 21)
Noctuidae	51 (Nos. 22-72)
Geometridae	18 (Nos. 73-90)
Cossidae	3 (Nos. 91-93)
Total (excluding Pyralidae and Micros)	93

The Pyralidae and Microlepidoptera of Bahrain are being studied by Dr. H. G. Amsel and an account of them will appear later.

Ecological groups of species of Lepidoptera

The Lepidoptera can be classed ecologically as follows:

1. *Migrants.* These are liable to occur equally in desert or oasis, but they are commoner in the latter, and in Bahrain they can for the most part only breed there. They are liable to appear on the wing and disappear together, e.g. *V. cardui.*

2. *Oasis-dwellers.* These are never found in the desert and thus are stenoecous; they might be subdivided according to foodplant, e.g. *Z. knysna karsandra.*

3. *Desert-dwellers.* These are never found in oases; some are very localised, doubtless due to the localisation of their foodplant, e.g. *C. trochylus.*

4. *Non-migrants common to both desert and oasis.* A few such moths have been observed (e.g. *Porphyrinia bulla*); it seems likely that the foodplant is *Zygophyllum album* or some other plant found on both habitats; alternatively, they may be polyphagous and unusually adaptive.

Geographical analysis

An analysis of the ranges of Bahrain's Lepidoptera, correlated with their habitats, is now given. As in Wiltshire (1957), the species are attributed each to a geographical category according to their present distribution. In a very small number of cases attribution was doubtful, but as these would tend to cancel out if incorrect, the general picture will hardly be affected. First, a brief definition of the category is given, then the total number of species, and lastly the ecological distribution in Bahrain, each actual species being referred to in brackets by its number in the list.

I. *Asiatic-Tropical.* Old-World Tropical species absent from Tropical Africa, with headquarters in southern Asia: Total 12, of which 3 are Migrants (1, 2, & 10), 6 are Oasis-dwellers (9, 14, 21, 35, 56, 74), 2 are Desert-dwellers (69 & 82), while 2 are found on both biotopes (2 & 10).

II. *Palaeo-Tropical.* Species widespread in Tropical Asia and Africa. Total 23, of which 14 or 15 are Migrants (4, 5, 7, 12. (?) 13, 15, 16, 20, 22, 37, 38, 39, 45, 67, 85); 16 are Oasis-dwellers (4, 5, 6, 12, 13, 15, 16, 22, 37, 44, 51, 52, 55, 57, 64, 72); only one (7) is a Desert-dweller, but 6 occur on both biotopes (20, 38, 39, 45, 67, 85).

III. *Holo-Tropical* or *Almost World-wide.* Species occurring in both hemispheres (Old and New World), especially in the Tropics: Total, 5, of which 3 at least (11, 18, & 23) are Migrants. Three are,

in Bahrain, Oasis-dwellers (23, 36, & 53) while two (11 & 18) are found on both oasis and desert ground.

IV. *Eurooriental.* Species of a warm-temperate or even sub-tropical range, widespread between western Europe and the Indus Valley with headquarters north of the Tropic, particularly strong in the Middle East. Total 10, of which 3 or 4 are Migrants (3, 17, 54, & 86). Seven are oasis-dwellers in Bahrain (3, 17, 28, 34, 41, 42, 81) while the other three occur in both desert and oasis (54, 76, & 86).

V. *Euro-Siberian.* Wide-ranging cool-temperate species, distributed between western Europe and eastern Asia. Total 1, an Oasis-dweller (70).

VI. *Pan-Eremic.* Species ranging through the arid zone from Morocco to Jordan and thence to central Asia; the range thus crosses that of (IV) above, in the Middle East. Total 4, all Desert-dwellers (27, 65, 92, 93).

VII. *Eastern Eremic.* Species inhabiting the arid zone from the Nile to south Persia. Total 20, none being Migrants. Six are Oasis-dwellers (8, 29, 77, 80, 84, 89) while 12 are Desert-dwellers (26, 46, 47, 48, 50, 58, 63, 75, 78, 83, 90, 91); there are also two species occurring in both biotopes (19 & 79). In this category, moreover, it seems possible to distinguish two limited smaller sub-categories or ranges: (*a*) species found only in Bahrain and Eastern Arabia (47, 48, & 91), and (*b*) species found only in Bahrain and south Persia (29 & 78). It seems likely that further exploration of S. Arabia and S. Persia will show that these two categories are in fact one, and perhaps constitute a peculiar 'Arabian or Persian Gulf' sub-category in the Eastern Eremics, and that the one apparent Bahrain Endemic (see below) also belongs here.

VIII. *Saharan-Sindian.* Species inhabiting the arid zone from Morocco to south Persia or the Sind Desert. Total 17, none being Migrants. Five are Oasis-dwellers (31, 40, 59, 71, 73), while 11 are Desert-dwellers (24, 25, 30, 32, 43, 60, 61, 62, 66, 68, 87). There is also one species inhabiting both biotopes (49).

IX. *Endemic species.* (Only known from Bahrain): Total 1, an Oasis-dweller (33).

The total of Eremic species, 42, contains not one Migrant, in the accepted sense, though of course many desert-dwellers and oasis-dwellers in this super-category are blown many miles from habitat to habitat; but this does not occur with the rhythm of the Migrants.

I shall not attempt again here to suggest centres of origin for these range-categories, as I have done this in Wiltshire (1957), and have also given my views on such theories in Wiltshire (1962).

The Migrants totalling 24 species are all either Tropical Euroriental or Almost World-wide species. Although not all have been recorded from both biotopes in Bahrain one can safely predict that all will eventually be found in both oasis and desert, though the former, as has been said, is their main breeding ground in Bahrain. In other parts of the desert and steppe zone, however, the desert may for a short season provide copious food for some of these. The extremely low rainfall figure of Bahrain is doubtless the reason why this is not the case here.

The Oasis-dwellers' total is 45, the Desert-dwellers' total 29. The total found on both biotopes is 19. Grand Total: 93.

Zoogeographical summary and discussion

Summarising these figures, one notes that one quarter of the whole Lepidopterous fauna is Migratory; that the Tropical component outnumbers the Temperate and Eremic in oases, while in the desert the Eremic predominates. The total absence of an African Tropical element contrasts notably with the strength of this component along the coast of southern Arabia. This confirms the dividing line between the two Tropical Regions suggested in Wiltshire (1952), i.e. a line running roughly from near Masira Island north-westwards to the heart of the Syrian Desert, leaving the Persian Gulf as completely Asiatic, in so far as the Tropical fauna is concerned. The true frontier, or natural barrier between the Ethiopian and Indian Regions, is thus desertic; the two epicontinental seas, the Red Sea and the Persian Gulf, are insignificant barriers.

Of the Eremic categories, the Pan-Eremic (the most northerly) is weakly represented, while the other two, the Eastern Eremic and Saharan-Sindian, are about equally strong.

The Bahrain fauna is thus a very mixed one. Its poverty is clear from the brevity of the list, with less than a hundred 'Macro-Lepidoptera', and no more than twelve or thirteen butterflies. Islands are, of course, nearly always poor in comparison with the adjacent mainland, but the poverty of Bahrain's fauna is less due to its isolation than the climate, which it shares with the nearest continental shores. For according to Marsh (1960) the number of butterfly species inhabiting Hong Kong, an island in much the same latitude but off the eastern coast of Asia with adequate rainfall for forest or un-irrigated cultivation, is 184 species, i.e. Hong Kong is 14 times richer.

Of Bahrain's 13 species, 6 actually also occur in Hong Kong (1, 5, 9, 10, 11, & 12).

The desert is the main stronghold of the really characteristic species of Bahrain, while the oasis, though richer in species, contains fewer such.

Ignoring, however, the characteristic Eremic species in the desert, we may alternatively conceive of the whole region with its small patches of oasis and its vast steppes, dunes, and stony desert, as a battlefield between the neighbouring faunas, the invaders' enemy being not the natives but the climate. If in time this should improve, more species of the surrounding regions will be able to effect a settlement; while if aridity increases further, the number of the invading species at first, and later even that of the natives, will be reduced. Taking an even longer view, we can add that the natives, or Eremic species, whether derived from Tropical or Temperate stocks, are those that have won the battle by age-long specialisation and evolution. An analysis of Bahrain's interesting fauna points to these conclusions.

Note on the collections and on previous publications

The list of Lepidoptera species which now follows is based on two collections made in 1959-1962:

(i) that of L/Aircraftsman D. Rush (1959-60), since presented to the British Museum,

(ii) that of E. P. Wiltshire (1959-62).

Descriptions of new species and forms from Bahrain found in these collections, together with other taxonomic notes, and illustrated by two half-tone plates and twenty black and white figures appeared in an article by the present author: 'A new genus, eight new species, seven new forms, and notes on the Lepidoptera of Saudi Arabia, Bahrain, and Iran' (*J. Bombay nat. Hist. Soc.* **58** (3) : 608-631, December 1961).

Biological notes with illustrations of larvae etc. from Bahrain (and also taxonomic notes on one species, namely *Thiacidas postica* Walker) appeared in an article by the present author entitled 'Early stages of Old World Lepidoptera, XII' [ibid. **59** (3) : 778-799, 4 Plates, December 1962].

The above two papers were the first two publications to deal with the Lepidoptera of Bahrain and the present paper should be studied in conjunction with them.

ANNOTATED LIST OF SPECIES

Explanation of abbreviations:

AT	Asiatic-Tropical	M	Migrant
D	Desert-dweller	O	Oasis-dweller
EE	Eastern Eremic	PE	Pan-Eremic
EN	Endemic	PT	Palaeo-Tropical
EO	Euroriental	R	Resident
ES	Euro-Siberian	SS	Saharan-Sindian

WW (Almost) World-Wide

See above for the definition of these terms.

The roman numbers i-xii refer to the calendar months.

Family Papilionidae

1. **Papilio demoleus** L.

O. Larvae of various sizes have been noted on *Citrus* in xii & vii. The imago has been seen flying in iv, v, vi, & viii. Any garden with oranges or limes may be a breeding ground, but the main centre is the oasis strip in the north-west. R. & M. AT.

Family Pieridae

2. **Colotis fausta** Oliv.

O. Seen flying in the north, in the oasis zone, in xi-61 and v-62. M. AT.

3. **Colias croceus** Fourc.

O. Several examples were taken at Budeia Farm about 31-iii-62, but it has not been seen at all otherwise. M. EO.

4. **Catopsilia florella** F.

O. One or two were taken about 31-iii-62 at Budeia Farm, but otherwise it has not been noticed. M. PT.

Family Lycaenidae

5. **Cosmolyce baeticus** L.

O. Noted on the wing in iii, v, vi, xi, and xii. Probably might be taken in any month, as it was not watched for. M. & R. PT.

6. **Tarucus rosaceus** Aust. (identity confirmed from ♂ genitalia)

O. A nearly full-grown larva attended by an ant was found on *Zizyphus spina-christi* on 2-xii-60. Imagines were seen flying in iii, iv, v, xi, & xii. R. PT.

7. **Freyeria trochylus** Courv.

D. Very local, only taken once and in one place, viz. Jebel Dokhan, rocky desert at *c.* 350 feet, certain water-courses, 9-xii-60. R. PT.

8. **Chilades galba** Led.

O. Not uncommon in oases, particularly gardens overgrown with its foodplant, *Prosopis stephaniana,* but sometimes also flying in singletons to flowers in gardens where this is not the case. Has been noted in v, but doubtless might be taken in some other months. R. EE.

9. **Zizeeria knysna** Trim. subsp. **karsandra** Moore

O. Common in oases, swarms in lucerne (or Alfalfa, Arab. *jett.*) fields in v, but also seen in most other months. R. AT (PT. if African subspecies is counted).

Family NYMPHALIDAE

10. **Junonia orithya** L. subsp. **cheesmani** Riley

A migrant, commonest in, and breeding in, oases, but also occasionally seen in the desert, e.g. Jebel Dokhan 26-xii-61. Has been noted in all months except vii, viii, & ix. Foodplant: *Lippia nodiflora* (see Wiltshire 1962a). AT.

11. **Vanessa cardui** L.

A migrant, not yet observed as breeding in Bahrain despite search for larvae, a winter visitor seen both in desert and oasis, seldom in numbers, but fairly regularly between x and iii. WW.

Family DANAIDAE

12. **Danaus chrysippus** L.

This migrant appears commonly and then disappears again. The only foodplant on the island is *Asclepias curassavica,* a rather infrequent garden flower. Observed in oases in ix-xii and again in iv & v. PT.

Family HESPERIIDAE

13. **Pelopidas thrax** Hübn. ssp. **midea** Walker

The only record is at Budeia Farm, 3-iv-62, an oasis locality. Until this locality has been more carefully studied all the year round, it would be premature to conclude that the specimens seen were no more than visiting migrants. O. PT.

Family Lasiocampidae

14. **Nadiasa siva** Lef.

R. Principally in oasis, on *Casuarina* (first record of any lepidoptera on this tree in Middle East!), *Zizyphus spina-christi* (Arab. *Nebk, Sadr*), Apricot (*Prunus armeniaca,* Arab. *Mish-mish*), *Prosopis stephaniana* (Arab. *Shok*), also, one larva only thriving on Oleander (*Nerium oleander*) (on which hitherto no larva other than that of *Daphnis nerii* has been noticed, owing, supposedly, to its poisonous properties). It is also seen occasionally breeding in the desert on *Acacia* stands (but these are very local; and it seems to disappear from these places in some years). The moth flies mainly in i-iii, the larva is most often seen in the autumn. AT.

Family Sphingidae

15. **Herse convolvuli** L.

The larva of this migrant has been noted in oases in v-vi. The foodplant grows in grassy places quite commonly and is a small *Convolvulus* sp. The adult occasionally comes to light in oases. Young larvae noted, 28-v-59. Imagines, 31-x-61. PT.

16. **Daphnis nerii** L.

The early stages and adult of this migrant are only seen in oases, and in the cooler months. Foodplant, *Nerium,* said to have been only recently introduced into Bahrain. Larvae noted mainly in xi, emergence of adult in i. PT.

17. **Macroglossa stellatarum** L.

The foodplant of this migrant does not grow on the island and it is a mere winter visitor. It has been seen in gardens on 2-xi-62 & 15-ii-62. EO.

18. **Celerio lineata** F. subsp. **livornica** Esp.

This migrant has occasionally been attracted to light in oases. Its larva has never been observed on the island. WW.

Family Arctiidae

19. **Nola harouni** Wilts. subsp. **dilmuna** Wiltshire, 1961

R. Mainly in oases. For details of early stages see Wiltshire 1962. The adult has been taken to light, or bred from larvae feeding on Papilionaceae, between xii and v. EE.

20. **Utetheisa pulchella** L.

This migrant is seen commonly on the wing in oases in most months except vii, viii, & xii; the larva has not been found, though looked for, on both species of Heliotrope, i.e. the desert-growing species *tuberculatus*, and a more lush species found on oasis ground. It has once been seen on the wing in the desert, namely on 19-xi-59 at Jebel Dokhan. PT.

Family Lymantriidae

21. **Euproctis cervina** Mre. (Plate III, figs. 7-8)

R. O. Flies in repeated broods between April and October; localised in gardens near the Adari Pool. Foodplants: *Terminalia catappa* (Indian almond) and *Alhagi maurorum* (Camel-thorn). For taxonomic details see Wiltshire 1961, and biological details Wiltshire 1962a. AT(?).

Family Noctuidae

22. **Scotia spinifera** Hübn.

Probably a migrant. Taken by D. Rush in x, 1959. PT.

23. **Scotia ipsilon** Hufn.

O.M. Seen occasionally, e.g. 18-xi-59, Manama Gardens. WW.

24. **Scotia herzogi** Rebel subsp. **saracenica** Tams

Found in similar places with the following species, but less common there. A univoltine moth appearing any time between xi & iii generally, but only taken in Bahrain on 4-iii-62. SS. R.

25. **Scotia sardzeana** Brandt

Resident in grassy, sandy patches of deserts; local in Bahrain, only in the southern desert, but common at the right season to light. Univoltine, taken on 5-xi-61, 17-xi-60, and 21.xi-62. SS.

26. **Scotia margelanoides** Boursin (Plate III, fig. 2)

One specimen only has been taken, to light at Muharraq, by Rush in xi, 59 (Prep. Wiltshire 1031), and may have been a vagrant from the mainland. EE. Other known habitats: Palestine and Arabia.

27. **Scotia lasserrei** Ob.

Common locally in the southern desert; univoltine, flying in xi. R. PE.

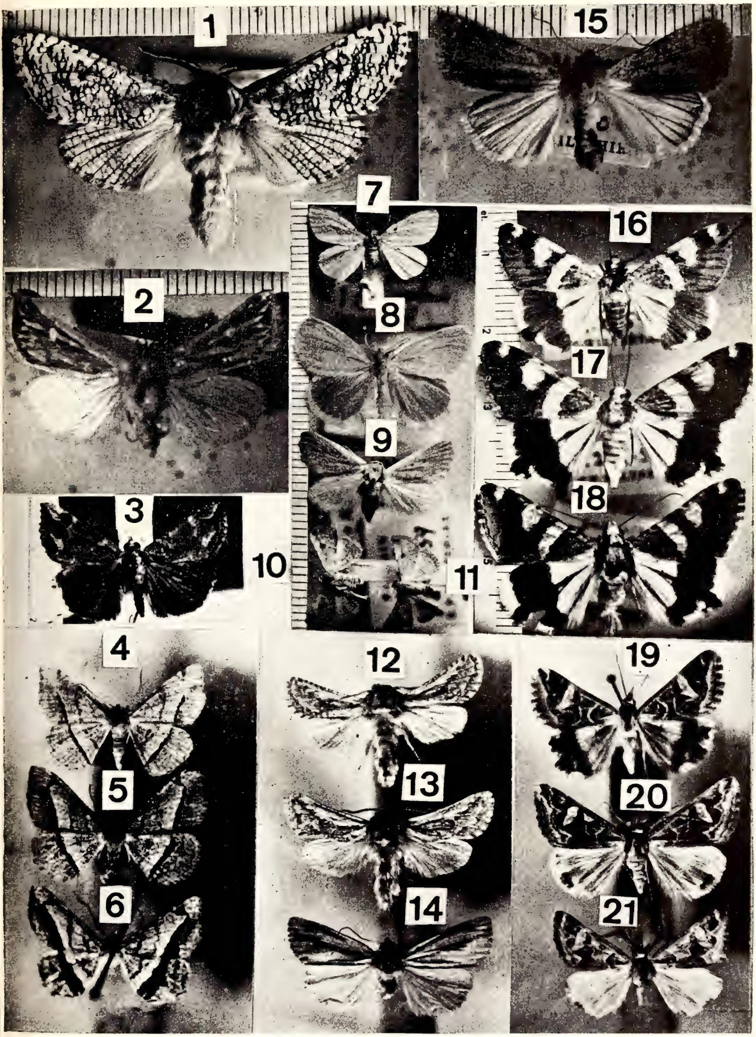


Fig. 1. *Lamellocossus cheesmani* Tams (91); 2. *Scotia margelanoides* Boursin (26); 3. *Hypena abyssinialis* Guenée (72); 4, 5, 6. *Semiothisa syriacaria* Staudinger (89); 7. *Euproctis cervina* Moore, gen. 3. male (21); 8. *Euproctis cervina* Moore, gen. 1 (21); 9. *Porphyrinia bella* Swinhoe (49); 10, 11. *Autoba gayneri* Rothschild (51); 12, 13. *Dyspessa vaulogeri* subsp. *jordana* Staudinger (93); 14. *Mythimna brandti* Boursin (29); 15. *Caradrina ingrata* Staudinger (40); 16, 17, 18. *Drasteria yerburyi* Butler (63); 19, 20. *Cerocala sana* Staudinger, females (58); 21. *Cerocala sana* Staudinger, male (58).

28. **Cardepia sociabilis** Grasl. subsp. **albipicta** Christ.

A halophile species, twice taken by Rush near the Adari Pool in xi. R. O. EO.

29. **Mythimna brandti** Boursin (Plate III, fig. 14)

Described in 1963 in *Arkiv. för Zoologi* **16** (8), Stockholm, this species was recorded by Brandt erroneously under the name '*Sideridis prominens* Walker' from south Persia. In Bahrain it is very local, one specimen having been taken flying over reeds and grass on the banks of the Adari streams, 8-iii-61. R.O. EE.

30. **Cleophana chabordis** Ob.

R.D. Flies in the southern desert in iii & iv. SS.

31. **Catamecia minima** Swinhoe

R.O. Taken near the Adari Pool in iii & v. SS.

32. **Scythocentropus inquinatus** Mab.

R.D. A univoltine moth, flying in x. Only one specimen has been taken in Bahrain, namely at Sakhir, 29-x-59. SS.

33. **Cryphia polyphaenoides** Wiltshire, 1961

The unique type, a ♀, taken on 23-ii-60 at the Adari Pool, remains the only known example of this species. R.O. EN.

34. **Hadjina viscosa** Freyer subsp. **persicola** Strand

Owing to localisation of its foodplant *Pluchea dioscoridis* in the Adari garden area, this moth is equally local. Both the adult and larvae were found near foodplant bushes on 27-iii-60 and the larva produced an adult on 17-iv. It is in fact a multivoltine species. R.O. EO.

35. **Perigea illecta** Walker

For the biology, see Wiltshire 1952. The foodplant and habits are similar to those of the preceding species. A male, taken on 22-i-60, Prep. Wiltshire 1047, and a further example bred from a larva, 19-iii-60. R.O. AT.

36. **Prodenia litura** F.

Probably a migrant, certainly a pest to agriculture, this moth was particularly numerous on the wing throughout iii-61 in the Adari gardens, but has also been seen in iv, v, and ix, always in oases. The larvae have been seen on lettuce in xii, and doubtless feed on various garden flowers and plants. WW.

37. **Spodoptera cilium** Gn. subsp. **latebrosa** Led.

Probably a migrant, common in gardens, but less so than the following species. Both feed on lawn grass. It is multivoltine and has been noted in iii, v, vii, ix, x, xi, & xii to light. O. PT.

38. **Spodoptera mauritia** Boisd.

Though commoner than the preceding in Bahrain, this species reaches less far north, and indeed in the Persian Gulf area is here at its northern limit. See Wiltshire 1962a for observations of its larva on lawn grass, and comparison of larva with that of *cilium*. It has been noted on the wing in ii, iii, iv, v, vii, ix, x, xi, & xii in Bahrain. The capture of one example (17-ii-60) in the desert is probably evidence that it is a migrant. All other records were in gardens. Multivoltine. PT.

39. **Layhygma exigua** Hübn.

This well-known pest and migrant, to judge from the dates of capture in Bahrain, is here more of a visitor and less of a breeding resident than the two preceding species, and indeed its larva has not yet been noted on the island. For its general biology and status in the Middle East adjacent to Bahrain see Wiltshire 1957. The moth has been taken to light occasionally in the desert but mostly in oases in iii-v, vii, & ix. PT.

40. **Caradrina ingrata** Stgr. (Text-fig.; Plate III, fig. 15)

An oasis moth, only taken in Bahrain at the Adari Pool, in iii. Its foodplant here is unknown, *Salix* (on which it was found in Basra, S. Iraq) being absent. Elsewhere in its range it appears to be at least bivoltine. Its range is Saharan-Sindian, and its male genitalia become increasingly asymmetrical towards the east. At present Bahrain is its easternmost known habitat, and ventral process of the right valve of Bahrain males is spatulate, while that of the left one tapers. In N. Africa both are alike, tapering; in Palestine some individuals tend slightly to a broadening of the right-hand process, and in S. Iraq the broadening approaches that remarked in Bahrain (see Text-fig., Prep. 1068). The female genitalia show no such cline.

41. **Heliothis nubigera** H.-S.

M. Occasionally to light in desert or oasis in the cooler months, e.g. i, x, xi. EO.

42. **Heliothis peltigera** Schiff.

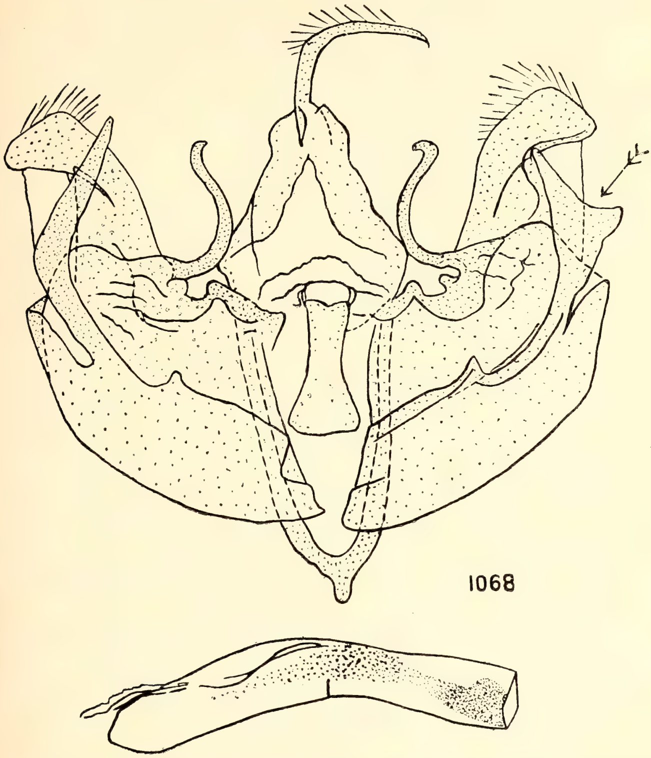
M. Once seen at light, Manama Gardens, 2-iii-60. EO.

43. **Timora albida** Hamps.

Rare, in the southern desert, 24-iii-62. SS.

44. **Porphyrinia cochylioides** Gn.

Once taken in Manama Gardens, 28-v-59. R(?). O. PT.



Text-fig. *Caradrina ingrata* Stgr. Male genitalia (Bahrain form). An arrow indicates the asymmetrically-formed right valve process.

45. **Porphyrinia parva** Hübn.

Has only been taken in the desert, in ii, x, & xi. R(?). PT.

46. **Porphyrinia pallidula** H.-S. subsp. **khalifa** Wiltshire, 1961

Fairly common in the desert in i, ii, ix, & xii. R. EE.

47. **Porphyrinia rushi** Wiltshire, 1961

Mainly in the southern desert, ii-iv. R.D. EE.

48. **Porphyrinia bistellata** Wiltshire, 1961

In the southern desert, mainly in iii-iv but occasionally also in x. R.D. EE.

49. **Porphyrinia bulla** Swinhoe (= *tomentalis* Rebel) (Plate III, fig. 9)

R. Very common in the desert in i-iv & x. Occasionally on oasis ground. SS.

50. **Porphyrinia straminea** Stgr. (?)

R.D. A single ♀ taken in the desert on 19-xi-59, was thought to be this species but, as no ♂ was taken and no further certain examples taken, its identification remains doubtful, likewise the claim of the species to be on the Bahrain list. The genitalia resemble the female genitalia of the preceding species, particularly the bursa-spiculation, but are comparatively larger, the posterior apophyses seeming also proportionately longer. EE.

51. **Autoba gayneri** Roths. (Plate III, figs. 10-11)

R.O. 18-xi-59, 9-i-60, 2-i-62. PT.

52. **Earias insulana** Boisd.

Occasionally taken to light in gardens in ii & iii. R.O. PT.

53. **Characoma nilotica** Rog.

Occasionally to light in ii in gardens. R.O. WW.

54. **Trichoplusia ni** Hübn.

This migrant occurs both in desert and oasis, doubtless breeding more in the latter. Taken to light in i, iii, & ix, adults have also been raised in iv from ova laid by a ♀ taken in iii. EO.

55. **Plusia daubei** Boisd.

As its foodplant elsewhere is reported to be *Pluchea* and this is found in Bahrain gardens, it may well be resident. However it is rare, only one example having been taken, 16-iii-61, Adari Pool. PT.

56. **Thiacidas postica** Walker [= *Raphia* (*Tiessa*) *cheituna* Brandt]

See Wiltshire 1962a for biological and taxonomic notes on this species. The foodplant is *Zizyphus spina-christi* (Arab. *Nebk, Sadr;* Christ-thorn). Bivoltine, flying in spring and autumn. The

autumnal larvae often defoliate whole branches of the tree. Many of them spend ten months in a pre-pupal coma in the cocoon instead of appearing in the spring on the wing. R.O. AT.

57. **Dysgonia torrida** Gn. (= *albivitta* Gn.)

This moth appeared in large numbers in the Adari gardens to *Prosopis spicigera* catkins in iii-60 but was otherwise not seen. R.O. PT.

58. **Cerocala sana** Stgr. (Plate III, figs. 19-21)

See Wiltshire 1962a for biological notes. It flies in the southern desert between late x and early iii. Foodplant, two species of *Helianthemum*. R.D. EE.

59. **Hypoglaucitis benenotata** Warren

Only one female has been taken, 26-ii-60, in Manama Gardens. It is surprising that it is not commoner, as the foodplant (*Tamarix articulata*, Arab. *Ithl*) is planted in several gardens. R (?). O. SS.

60. **Cortyta vetusta** Walker

Comes to light occasionally in the desert during the cooler months, xii-iv. R (?). D. SS.

61. **Cortyta acrosticta** Pung. (= *rosacea* Rebel)

Known to feed elsewhere on *Acacia*, this desert moth has once been taken, on 28-iv-62, in the desert. R (?). D. SS.

62. **Gnamptonyx vilis** Walker

Also known to feed on *Acacia* elsewhere, this moth has similarly been taken in two examples only in the southern desert on 28-iv-62. R (?). D. SS.

63. **Drasteria yerburyi** Butler (= *pica* Brandt) (Plate III, figs. 16-18)

See Wiltshire 1962a for biological and other notes on this species. Foodplant: *Taverniera spartea*. In those parts of the desert where this grows it flies during the cooler months ix-iv, and the larva may be found at night on the plant during the same season. R.D. EE.

64. **Mocis frugalis** F. subsp. **nigripunctata** Warren

Flies in the grassier gardens between xi and iv, both by day and to light. See Wiltshire 1962a for biological notes; the foodplant is grass. R.O. PT.

65. **Anumeta spilota** Ersch.

The relationship between *spilota* and *harterti* Roths. not having been cleared up, and both forms seeming to inhabit Bahrain and Eastern Arabia, it is not clear if one has one or two species to deal with. Assuming provisionally that they are one, one can only say that this Pan-Eremic desert-dweller appears rather rarely in the deserts of Bahrain in x and iv.

66. **Anumeta straminea** B.-Haas.

1 ♀ on 5-xi, and 10 ♀♀ on 13-xii-61, and 1 ♂ on 5-ii-62, all coming to light at the same grassy locality in the southern desert. In the Sahara there is also a June emergence, but this has not been observed in Bahrain. R.D. SS.

67. **Pandesma anysa** Gn.

This migrant has been taken in the desert in iii and on oasis ground in vii. The gardens doubtless contain trees on which it could feed, but the early stages have not been seen here. M. PT. (or SS.).

68. **Acrobyla kneuckeri** Rebel

See Wiltshire 1962a for biological notes. In Bahrain this moth has only been taken in x, xi to light in the desert at Sakhir (an *Acacietum*) but there is presumably also a spring flight. R.D. SS.

69. **Acantholipes circumdata** Walker subsp. **affinis** Walker

See Wiltshire 1962a for biological notes. Rather rare in Bahrain. The foodplant is *Taverniera spartea* and the phenology seems much the same as that of no. 63 above, with which the species occurs, but is less common. R.D. AT.

70. **Rivula sericealis** Scop.

R.O. 25 & 29-iii-60, Adari Pool. ES.

71. **Rhynchodontodes revolutalis** Z. (= *syriacalis* Stgr., *eremialis* Walk.)

R(?). O. In wild parts of gardens where *Alhagi* (camel-thorn) grows profusely this moth is liable to appear in almost any month of the year. The fact that it has also been taken on jetty-rocks surrounded by the sea in x suggests that it may migrate. SS.

72. **Hypena abyssinialis** Gn. (Plate III, fig. 3)

Flies in moist oases, such as the Adari gardens in ii-iv. R. PT.

Family GEOMETRIDAE

73. **Pingasa lahayei** Ob. subsp. **multispurcata** Prout

R.O. 6-iv-60, Awali; 12-iii-61, Adari. SS.

74. **Chlorissa discessa** Walker

See Wiltshire 1962a for biological notes. Flies in oases in two or three generations between xi and v. R.O. AT.

75. **Neromia pulvereisparsa** Hamps.

Very local in deserts, never far from rather high rocks, in which situation alone its foodplant, *Ochrodenus baccatus,* grows (the larva however was not found on this plant here, but in Egypt). Flies in two generations, xi & ii. R.D. EE.

76. **Microloxia herbaria** Hübn.

Here at its eastermost limit, this little moth flies in the Adari gardens and also in the desert near Jurdeh, about two miles north of them, in two generations, ix-xi and ii-iii. R. EO.

77. **Sterrha granulosa** Warren

R.O. 28-ix-59, 21-v-60, 8-v-61, Adari Pool. Though distinctly an oasis-dweller here, this same species is a desert-dweller in Egypt-Sudan. EE.

78. **Sterrha mimetes** Brandt

R.D. Not uncommon in iii, iv, & ix-vi. See Wiltshire 1962a for biological notes. EE.

79. **Sterrha illustris** Brandt

Has been taken in iii, twice in the desert and once on oasis ground. R. EE.

80. **Scopula adelpharia** Pung.

See Wiltshire 1962a for biological notes. R.O. EE. Multivoltine, flying in almost every month.

81. **Scopula ochroleucaria** H.-S.

See Wiltshire 1962a for biological notes. R.O. EO. Multivoltine, flying in almost every month.

82. **Zygophyxia relictata** Walker

Occasionally taken to light in ii in the desert near Jurdeh. R.D. AT.

83. **Cosymbia rufistrigata** Hampson

Occasionally to light in ii & iv in the southern desert, very fresh specimens. R.D. EE.

84. **Cosymbia mundissima** Walker

Not uncommon in the Adari gardens, in xi & i. R.O. EE.

85. **Rhodometra sacraria** L.

This migrant has been taken in both oasis and desert, in x & ii. PT.

86. **Rhodometra antophilaria** Hübn.

Two ♀♀ were taken by Rush; their markings seem to indicate their identity as above, and Mr. D. S. Fletcher of the British Museum who has studied the group, now confirms it. It is probable, but not yet proved, that this species is a migrant like No. 85. M (?). EO.

87. **Eupithecia tenellata** Dietze.

Local in the southern desert. R.D. 7-iii-60. SS.

88. **Tephrina perviaria** Led.

Local, only where *Acacia* grows, in the desert at Sakhir and possibly in certain oases. The moth flies x & iv. R.D. AT.

89. **Semiothisa syriacaria** Stgr. (Plate III, figs. 4-6)

R.O. Localised with its foodplant, *Prosopis stephaniana*. See Wiltshire 1962a for biological notes. Multivoltine, flying throughout the summer months, but not during the cooler months when its food-plant is leafless. Bahrain is probably its southernmost limit. The form is very dark-marked, all f. *tenuiata* or even darker-banded forms. EE.

90. **Jordanisca tenuisaria** Stgr.

A desert moth, not uncommon over the rather wide area where *Lycium persicum*, its foodplant, grows. Univoltine, with a flight season spread over the cooler months, xi-ii. Probably *Hemerophila brandti* Wehrli is a synonym, in which case its range includes S. Persia. EE, from Palestine to Bahrain at least.

Family Cossidae

91. Lamellocossus cheesmani Tams (Nov. Comb.) (Plate III, fig. 1)

The form is slightly darker than the type from Jabrin on the mainland. It flies in the southern desert of Bahrain during the cooler months, xi-i, but is uncommon. A possible foodplant is the tree *Leptadenia;* alternative, *Lycium,* would appear too small for so large a borer. R.D. EE.

92. Holcocerus gloriosus Ersch. subsp. **mesopotamicus** Watkins

Very local but fairly common to light in the *Tavernieretum* of the desert near Jurdeh in v. On the roots of this plant it is presumed to feed. Univoltine. R.D. PE.

93. Dyspessa vaulogeri Stgr. subsp. **jordana** Stgr. (Plate III, figs. 12-13)

R.D. In the same desert locality and probably dependent on the same foodplant as the preceding, no. 92. It flies, however, earlier, in ii-iii, being also univoltine. The Bahrain form appears to me closer to that of Palestine than that of S. Persia, while smaller than that found in S. Iraq and Kuwait. PE.

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Eco-toxicology and Control of the Indian Desert Gerbille, *Meriones hurrianae* (Jerdon)

II. Breeding Season, Litter Size, and Post-natal Development

BY

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(*With a plate and two text-figures*)

[*Continued from Vol.* **59** (3) : 806]

INTRODUCTION

This paper, second in the series, deals with some aspects of the life-history of the Indian Desert Gerbille, *Meriones hurrianae* (Jerdon) (Rodentia, Gerbillinae). This rodent is abundant in the Rajasthan desert but being wary is very difficult to trap. They were, however, collected by flooding their warrens. They did not breed in the initial stages. Most of the observations are, therefore, on litters borne by pregnant females collected in the field. Usually deliveries occurred at night. A pad of cotton was invariably provided to the female which she utilised for placing the young on. In all, ninety-nine new-born young were handled in the laboratory. The rate of mortality due to the cannibalism of the mother was rather high. Some young died in an attempt to administer ether for taking measurements. After that measurements and weights were recorded on live specimens, and are analysed according to the procedures described by Brody (1945) and Butterworth (1961). Values are plotted in figure 1. Straight segments of the graph indicate periods when growth increments are constant percentages of previous sizes. From these straight sections, instantaneous growth rates were calculated according to the following formula:

$$k = \frac{\ln m_2 - \ln m_1}{t_2 - t_1}$$

where k is the instantaneous percentage rate of growth for the unit

Meriones hurrianae

Litter of three
Faces of two nibbled by the mother.

Litter of seven

Litter of nine

Photos : Ishwar Prakash

of time in which t_2 and t_1 are expressed, and $\ln m_2$ and $\ln m_1$ are natural logarithms of the measurements at t_2 and t_1 (Butterworth 1961).

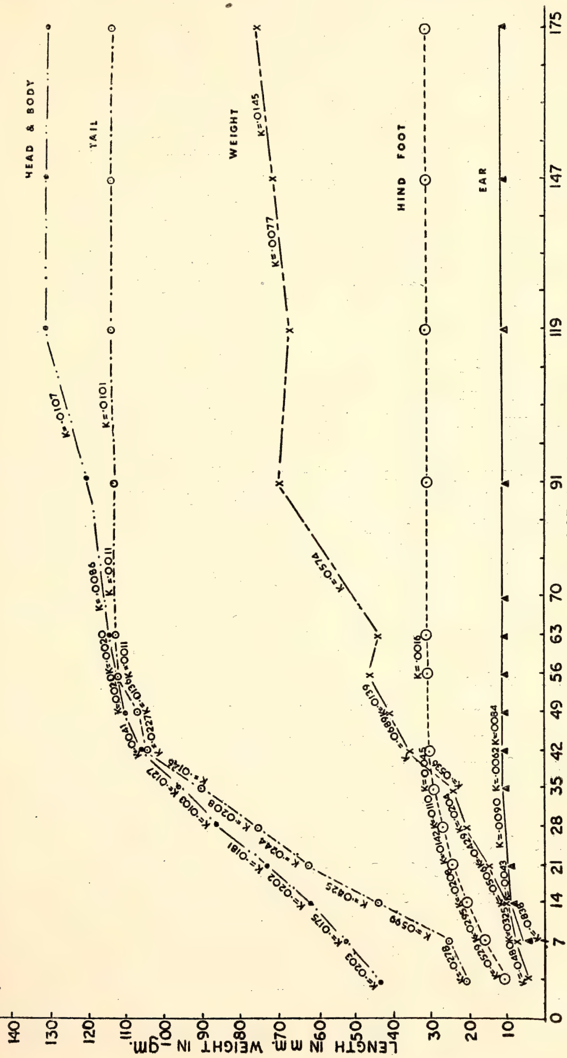

Fig. 1. Graph of growth of *M. hurrianae* from birth till 25 weeks of age. Instantaneous relative growth rates are shown above weekly segments of the plot.

Observations and Discussion

Seasonal incidence of breeding

Females littered throughout the year (Table I). It will be noticed that there are two peaks in the incidence of births: February and July. The gerbilles pass the cold spell in December and January in a state of torpidity. As soon as this torpidity is over, sexual activity increases and hence the peak in births in February. The increased activity in July is attributed to the optimum conditions existing during the rainy season in the desert (Prakash 1960). It was earlier observed that the gerbille litters only during August-October (Prakash 1960, 1962). This observation was based on the field collection of pregnant females during 1953-56. The collection of the gerbilles in various months has, however, shown that they breed all the year round (Table I).

Gestation period

The period of gestation in *Meriones hurrianae* is not correctly known. A female littered on the night of February 11. The next morning the male gerbille was removed from the cage. Mother and the young remained in the cage. The female again littered on the night of March 13. It appears that the male served the parturient mother in the morning of February 12. The period of gestation was 30 days. In another case a female gerbille was introduced to a male and they mated the same afternoon. The delivery occurred after 28 days. In two more instances the period of gestation was found to be 28 and 29 days.

Parturition

Parturition was observed only in one female. In the laboratory, she delivered two young in the early morning which was not observed. At 10 a.m. the mother was noticed to be extremely uneasy and at 11 a.m. she delivered one whitish, dead young. The head was presented first and the entire body was, thereafter, almost dropped. Just before delivery a whitish fluid oozed out but there was no discharge of blood. During delivery the mother lay flat on her belly with her hindquarters raised slightly above the floor of the cage. Her eyes were closed and hind region was quivering. Only with great difficulty could she walk. At 12.30 p.m. the mother delivered another young, head first. This time the body of the mother shook violently and she kicked her hind limbs while lying flat on the floor of the cage. The mother did not appear to pay attention to the

TABLE I

SHOWING THE SEASONAL INCIDENCE OF BREEDING

Months	Jan.	Feb.	March	April	May	June	July	August	Sep.	Oct.	Nov.	Dec.
Number of litters born ..	4	11	2	1	1	2	8	6	4	5	4	6
Total number of females collected ..	15	26	9	7	8	10	14	12	8	12	14	22

TABLE II

SHOWING THE LINEAR MEASUREMENTS AND WEIGHTS OF THE NEW-BORN IN VARIOUS LITTER SIZES

Size of litter		1	3	4	5	6	7	9
Total number of young measured		1	20	28	15	12	14	9
Head & body	mm.	40.0	39.1 ± 0.31	40.7 ± 0.83	40.6 ± 0.94	38.8 ± 0.23	39.4 ± 0.21	43.3 ± 0.25
Tail	mm.	12.0	12.3 ± 0.76	12.1 ± 0.43	11.0 ± 0.37	10.5 ± 0.11	11.5 ± 0.19	20.00
Hind foot	mm.	8.0	7.6 ± 0.22	8.7 ± 0.37	7.0	6.9 ± 0.03	7.25 ± 0.13	10.00
Weight	gm.	4.2	4.4 ± 0.31	4.2 ± 0.28	3.04 ± 0.18	4.06 ± 0.13	4.02 ± 0.02	4.8 ± 0.09

young which lay half curled, on its back, moving its limbs in the air. Twenty-five minutes later she got up and licked the young one, collected it, and carried it to the cotton pad.

New-born young and litter size

At birth the young is hairless except for the 3-4 mm. long vibrissae. The body is pink in colour. Eyes are closed, and appear as dark spots. The external auditory meatus is closed and the pinna is folded. The claws are whitish, soft, and 2 mm. long. The nipples were not visible in either sex. The sexes could not be differentiated. Young were unable to walk when a few hours old but could sway their limbs. They started squeaking within 4-6 hours of birth. They also opened their mouth and tried to grasp anything which touched their lips. Suckling started 3 to 6 hours after delivery.

The litter size varies from 1 to 9 (Table II), but is commonly three or four. Of the 23 litters born in the laboratory, the litter size was: 7 each of 3 and 4 young, 3 cases of 5 young, 2 cases each of 6 and 7, and one each of 1 and 9 young. It is natural to expect that the size of the young will be smaller in a large litter, but the data in Table II reveal that the average size of the young in the litter of 9 was the biggest. The data also show the average linear measurements and weights of the new-born ones and their standard error according to various sizes of the litters. The averages of the ninety-nine young are : head and body, 40.2 ± 0.60 mm. ; Tail, 12.8 ± 1.21 mm. ; hind foot 7.9 ± 0.42 mm. ; and weight, 4.1 ± 0.21 gm.

Rate of post-natal development and behaviour of the young

First week. From the third day the dorsum of the young started darkening, beginning as a mid-dorsal line which gradually broadened and extended on the lateral sides. The unfolding of the pinna started from the 4th and 5th day after birth. The incisors could be felt below the gums. The vibrissae grew to 12-15 mm. The claws elongated but without pigmentation. The young one could crawl but was unable to support its body on its limbs.

Second week. Short, fine pelage appeared on the dorsum of the young, and by the end of the week extended to the flanks. A thin pencil of hairs appeared at the tip of the tail. The young gave a general impression of sepia colour. The vibrissae measured 30 mm. and their tips became black. Plantar pads appeared on the hind foot but were feeble on the fore paw. The claws darkened. The eyes were still closed but at the end of the week a groove appeared at the centre, separating the lids. Incisors appeared in the jaws. Suckling continued.

Third week. Hair cover became complete and the pencil of hairs at the tip of the tail became darker. The vibrissae attained a length of 36-40 mm. The external auditory meatus opened. The upper incisors measured 1.5 and the lower 5.5 mm. The plantar pads of the hind limbs developed fully but those on the fore paws were still growing. The eyes opened after 15 to 16 days. Suckling ceased from 18 to 20 days. These two periods were observed in 8 and 6 cases only. The young could walk and chased the mother.

Fourth week. Fur on the young developed fully. The white incisors, now 4 mm. (upper jaw) and 8.5 mm. (lower jaw), became paler. The pads of the fore feet also developed fully. The claws darkened completely. The external genitalia of either sex became distinguishable. The young were able to run and started thumping the ground with the hind foot as the sign of danger.

TABLE III

SHOWING THE PER CENT. GROWTH OF THE NEW-BORN

	Per cent. growth in					
	first 4 weeks	next 4 weeks	next 5 weeks	next 4 weeks	next 4 weeks	next 4 weeks
Head and body ..	48.6	29·4	9.3	12.7	..	..
Tail ..	58.4	38.6	1.8	1.2	..	..
Ear ..	81.5	18.5 (6th week)	..	..	..	..
Hind foot ..	80.9	17.2	1.9	..	..	..
Weight ..	21.9	36.9	33.5	..	2.1	5.6

Subsequent growth

It will be observed further from the data in Table III that the rate of growth is very high in the first four weeks. 81.5 per cent. growth of the ear and 80.9 per cent. of the hind feet is attained in this period. 78 per cent. head and body and 97 per cent. tail growth is attained by the eighth week, whereas the ear and hind feet attain maximum dimensions by the sixth and eighth week respectively. Increase in body weight is gradual and 92.3 of the total is gained by the thirteenth week. Figure 2 shows the relationship between the weight and head-and-body length of the young studied in the laboratory.

Care of the young and cannibalism

Parturient mothers took about 25 to 30 minutes after delivery for taking care of the new-born young. Lactation started after 3 to

FIG. 2. OVER-ALL LENGTH PLOTTED AGAINST WEIGHT IN YOUNG DESERT GERBILLE FROM BIRTH TILL 25 WEEKS OF AGE.
The range of variation increases as development proceeds.

6 hours. Mothers were usually docile when their young were removed for measurements; they were not aggressive to their young when they were put back. Contrary to this, Fitch (1957) observed

that the mother Prairie Vole, *Microtus ochrogaster*, attacked her young viciously and killed them within a few seconds, as soon as they were put back. When disturbed, the gerbille mother usually picks up its young ones and huddles them in a corner or under the cotton pad and starts suckling them.

During the height of the breeding period, cannibalistic tendencies in the mother towards the new-born and of males towards the young were noticed and may be an important factor in the population dynamics of this species.

SUMMARY

The Indian Desert Gerbille, *Meriones hurrianae* (Jerdon), breeds throughout the year. The gestation period varies from 28 to 30 days and the litter size from 1 to 9.

The young are born naked. Their eyes open 15/16 days after birth. Suckling lasts for 18 to 20 days.

The rate of post-natal development is very high during the first four weeks. 81.5% development of the ear and 80.9% of hind feet is attained during this period. 78% and 97% development of head and body-and-tail are attained by the eighth week. The instantaneous per cent growth has been mathematically expressed.

Strong cannibalistic tendency prevails during the breeding activity which is an important factor influencing the dynamics of growth of the population.

ACKNOWLEDGEMENTS

I feel indebted to Dr. P. C. Raheja, Director, Central Arid Zone Research Institute, Jodhpur, for encouragement throughout the period of study, and to Dr. Pulak K. Ghosh, Animal Physiologist, for help in this study.

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Epizoic associates of the Bombay Spiny Lobster *Panulirus polyphagus* (Herbst)

BY

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(*With one plate*)

The lodgements of sedentary epizoa on such an unusual substratum as a lobster not only make interesting records but are often suggestive of the environment and the normal intermoult period of the host. Good and accurate descriptions of epizoic associates of the American lobster *Homarus americanus* (M. Edw.) are given by Herrick (1895, p. 121) and Dexter (1955, p. 160), and of the Norway lobster *Nephrops norvegicus* (L.) are given by Barnes & Bagenal (1951) and Andersen (1962, p. 307). Recently Dinamani & Kurian (1961) have published a note on pedunculate cirripeds infesting the spiny lobster *Puerulus sewelli* Ramadan collected off Kerala. However, no noteworthy account of the epizoa of commercially important Indo-Pacific spiny lobsters is available.

During the course of investigations on the biology of *Panulirus polyphagus* (Herbst) the author was able to examine more than 4000 specimens for the presence of any macroscopic epifauna. These spiny lobsters were caught in inshore waters (2-6 metres) and offshore waters (30-70 metres), in hoop nets and trawls respectively. The average weight of the spiny lobster having epizoa was 362 gm. and, except for the specimens specifically noted in Table I, the condition of the shell was hard. The carapace length was measured to the nearest 2.5 mm. from the antennular tergum to its posterior margin.

In contrast to *P. polyphagus*, which constitutes as much as 99% of the total spiny lobster population around Bombay (Chhapgar & Deshmukh 1961), the other species *P. dasyps* (H. Milne Edwards), *P. versicolor* (L.), and *P. ornatus* (Fabr.) whenever examined for any macroscopic epizoa were found to be negative, possibly due to the extremely small number available for examination. In the case of the squat-lobster *Thenus orientalis* (Lund), however, which also is found

TABLE I

PERCENTAGES OF *Panulirus polyphagus* FOUND ENCRUSTED WITH EPIZOA

Date	Depth, gear, and no. of specimens collected	Percentage of total catch	Epizoic species	Attachment site and abundance	Carapace length	Remarks
4-6-1960	50 metres, Trawl net, 3	3.19	*Serpulid* (tube-forming annelid)	Carapace (1250 sq. mm.) and Sternum (150 sq. mm.)	11.0 cm.	
			do.	Sternum (two tubes)	9.75 cm.	
			Balanus amphitrite	Between the orbital spines (one)	12.5 cm.	
25-7-1960	60 metres, Trawl net, 6	15.00	*Balanus amphitrite*	Carapace (four)	10.5 cm.	
				Carapace (three) Left antenna (one)	10.0 cm.	
				Carapace (one)	10.5 cm.	
				Carapace (two young)	8.5 cm.	Newly moulted
				Carapace (19 young)	9.5 cm.	Newly moulted
				Antennae (7 young) Carapace (one)	10.0 cm.	
31-8-1960	52 metres, Trawl net, 2	7.69	*Balanus amphitrite*	Carapace (one)	9.0 cm.	
				Carapace (two)	11.5 cm.	
4-9-1960	6 metres, Hoop net, 1	2.44	*Ostrea cucullata*	Sternum (two young)	7.5 cm.	

TABLE I (*continued*)

Date	Depth, gear, and no. of specimens collected	Percentage of total catch	Epizoic species	Attachment site and abundance	Carapace length	Remarks
23-9-1960	66 metres, Trawl net, 5	20.00	*Balanus amphitrite*	Carapace (three)	10.0 cm.	Plate, Fig. 2
				Carapace (two)	10.5 cm.	
				Carapace (four)	10.5 cm.	
			Octolasmis warwickii (Gray)	First tergum (one)	9.75 cm.	
			Balanus amphitrite	Carapace (six)	10.0 cm.	
18-11-1960	4 metres, Hoop net, 1	2.00	*Acanthodesia* (Encrusting bryozoan)	Carapace (375 sq. mm.)	11.0 cm.	
16-2-1961	40 metres, Trawl net, 1	2.04	*Balanus amphitrite*	Carapace (four)	10.0 cm.	
4-4-1961	50 metres, Trawl net, 2	5.00	*Balanus amphitrite*	Carapace (three)	8.75 cm.	
				Carapace (five)	10.5 cm.	
11-4-1961	44 metres, Trawl net, 2	7.14	*Balanus* sp.	Sternum (one young)	10.0 cm.	
			Balanus amphitrite	Carapace (three)	10.75 cm.	
23-4-1961	54 metres, Trawl net, 5	8.07	*Balanus amphitrite*	Carapace (three)	12.25 cm.	
				Carapace (two)	11.0 cm.	
				Second tergum (one)	10.5 cm.	
				Carapace (one)	10.5 cm.	
			Balanophyllia sp. (Coral), & *Balanus amphitrite*	Carapace (one each)	11.25 cm.	
				Carapace (one each)		
17-5-1961	6 metres, Hoop net, 1	2.50	*Balanus amphitrite*	Sternum (three)	11.0 cm.	Plate, Fig. 1

26-6-1961	40 metres, Trawl net, 4	13.95	*Balanus amphitrite*	Carapace (three) Uropod (two)	10.0 cm.	
				Carapace (four)	9.5 cm.	
				Carapace (one)	10.75 cm.	
			Chelonibia patula *Balanus* sp.	Carapace (one) Carapace (two, young)	11.75 cm.	
	64 metres, Trawl net, 2	13.95	*Balanus amphitrite*	Carapace (two)	10.75 cm.	
25-9-1961	4-6 metres, Hoop net, 1	3.03	*Ostrea* (*Crassostrea*) *cucullata*	Carapace (five young)	10.5 cm.	
10-10-1961	48 metres, Trawl net, 3	11.11	*Balanus amphitrite*	Carapace (three) Carapace (three)	9.25 cm. 11.0 cm.	
			Octolasmis tridens (Aurivillius)	Carapace (five very small)	9.75 cm.	Newly moulted
			Balanus amphitrite	Carapace (one)		
1-2-1962	60 metres, Trawl net, 3	7.50	*Balanus amphitrite*	Carapace (four) Carapace (one) Carapace (two)	10.0 cm. 11.25 cm. 10.25 cm.	

TABLE I (*continued*)

Date	Depth, gear, and no. of specimens collected	Percentage of total catch	Epizoic species	Attachment site and abundance	Carapace length	Remarks
23-9-1960	66 metres, Trawl net, 5	20.00	*Balanus amphitrite*	Carapace (three) Carapace (two) Carapace (four)	10.0 cm. 10.5 cm. 10.5 cm.	
			Octolasmis warwickii (Gray)	First tergum (one)	9.75 cm.	Plate, Fig. 2
			Balanus amphitrite	Carapace (six)	10.0 cm.	
18-11-1960	4 metres, Hoop net, 1	2.00	*Acanthodesia* (Encrusting bryozoan)	Carapace (375 sq. mm.)	11.0 cm.	
16-2-1961	40 metres, Trawl net, 1	2.04	*Balanus amphitrite*	Carapace (four)	10.0 cm.	
4-4-1961	50 metres, Trawl net, 2	5.00	*Balanus amphitrite*	Carapace (three) Carapace (five)	8.75 cm. 10.5 cm.	
11-4-1961	44 metres, Trawl net, 2	7.14	*Balanus* sp. *Balanus amphitrite*	Sternum (one young) Carapace (three)	10.0 cm. 10.75 cm.	
23-4-1961	54 metres, Trawl net, 5	8.07	*Balanus amphitrite*	Carapace (three) Carapace (two) Second tergum (one) Carapace (one)	12.25 cm. 11.0 cm. 10.5 cm. 10.5 cm.	
			Balanophyllia sp. (Coral), & *Balanus amphitrite*	Carapace (one each) Carapace (one each)	11.25 cm.	
17-5-1961	6 metres, Hoop net, 1	2.50	*Balanus amphitrite*	Sternum (three)	11.0 cm.	Plate, Fig. 1
26-6-1961	40 metres, Trawl net, 4	13.95	*Balanus amphitrite*	Carapace (three) Uropod (two) Carapace (four) Carapace (one)	10.0 cm. 9.5 cm. 10.75 cm.	
			Chelonibia patula *Balanus* sp.	Carapace (one) Carapace (two, young)	11.75 cm.	
	64 metres, Trawl net, 2	13.95	*Balanus amphitrite*	Carapace (two)	10.75 cm.	
25-9-1961	4-6 metres, Hoop net, 1	3.03	*Ostrea* (*Crassostrea*) *cucullata*	Carapace (five young)	10.5 cm.	
10-10-1961	48 metres, Trawl net, 3	11.11	*Balanus amphitrite*	Carapace (three) Carapace (three)	9.25 cm. 11.0 cm.	
			Octolasmis tridens (Aurivillius)	Carapace (five very small)	9.75 cm.	Newly moulted
			Balanus amphitrite	Carapace (one)		
1-2-1962	60 metres, Trawl net, 3	7.50	*Balanus amphitrite*	Carapace (four) Carapace (one) Carapace (two)	10.0 cm. 11.25 cm. 10.25 cm.	

only occasionally, two instances could be recorded, one having three young *Tubularia* colonies and the other having nine young specimens of goose-barnacle, *Octolasmis tridens* (Aurivillius). Both the squat-lobsters were adult females and had the epizoa on the carapace.

The recorded epizoic incrustations of *P. polyphagus* are summarised in Table I.

The epizoic associates

The percentage occurrences of various epizoa of *P. polyphagus* were found to be as follows:

Table II

Percentage of occurrence of Epizoa

Species	Percentage
(1) *Balanus amphitrite* (Darwin)	80.00%
(2) *Chelonibia patula* (Ranzani)	2.22%
(3) *Octolasmis warwickii* (Gray)	2.22%
(4) *Octolasmis tridens* (Aurivillius)	2.22%
(5) *Serpulid* (Tube-building annelid)	4.44%
(6) *Ostrea* (*Crassostrea*) *cucullata* Born.	4.44%
(7) *Balnophyllia* sp. (coral)	2.22%
(8) *Acanthodesia* sp. (bryozoan)	2.22%

Sessile Barnacles. The dominant balanid *Balanus amphitrite* (Darwin), constituting as much as 80% of the total epizoa records, appears to be the commonest incrusting associate of the Bombay spiny lobster (Plate, fig. 1). Herrick (1895, p. 122) in his classic monograph on the American lobster aptly remarks: 'Whenever the lobster is confined in inclosures or compelled for any reason to lead a sluggish life, the common barnacle fixes itself to the arched carapace and begins to secrete its tent-like covering as securely as it might upon a stone.' It will be clear from columns 4-5 of Table I that balanids alone are capable of settling on any part of the *P. polyphagus* shell. In most of the instances only a single barnacle population had settled on the shell while a very few had two different barnacle populations growing on the body.

The subspecies of *Balanus amphitrite* commonly epizoic on *P. polyphagus* were found to be *B. amphitrite variegatus* (Darwin) and *B. amphitrite hawaiiensis* (Broch). A single specimen of the latter subspecies has been recorded by Nilsson-Cantell (1938) on the crab *Schizophrys aspera* from the Persian Gulf. *Balanus amaryllis* (Darwin) recorded by him as epizoic on *Palinurus* (?) sp. from the Balasore Bay of Orissa, however, is not yet known from Bombay.

The other balanomorphid found epizoic on the Bombay lobster was the turtle barnacle *Chelonibia patula* (Ranzani). In this particular instance the lobster also had two much younger *Balanus* specimens on the carapace. *C. patula* in epizoic state on a decapod has also been recorded earlier by Nilsson-Cantell (1938) and Daniel (1956) on the crab *Scylla serrata* (Forsk.) collected from Lake Pulicat, Madras.

Pedunculate Barnacles. Two species of *Octolasmis*, viz. *O. tridens* (Aurivillius) and *O. warwickii* (Gray) were found to be epizoic on *P. polyphagus.* This is incidentally a new record for both these pedunculate species from Bombay.

As mentioned earlier *O. tridens* was found epizoic on *Thenus orientalis* also. Similar instances of *Octolasmis tridens* epizoic on *T. orientalis* have been reported by Annandale (1909) from Orissa coast and by Nilsson-Cantell (1938) from Singapore. Annandale has mentioned *O. warwickii*, besides, as occurring on *T. orientalis* from Orissa and Hughli river mouth.

A noteworthy record of heteralepadid cirriped settling on a panulirid lobster is reported earlier by Barnard (1924, p. 62) for *Paralepas palinuri* (Barnard) from shallow waters of S. Africa. The subspecies *urae* (Newman) of *Paralepas palinuri* has been more recently reported by Newman (1960, p. 112) from the maxilliped of *Panulirus penicillatus* (Oliv.).

The other earlier records of lepadomorphids settled on carapace, limbs, mouthparts, and gill-chamber entrance of spiny lobsters are given by Annandale (1909) for *Octolasmis warwickii* from the Orissa coast, *O. cor* (Aurivillius) from the Indian Ocean, *O. angulata* (Aurivillius) from Bombay and Orissa coast, *O. sinuata* (Aurivillius) from Red Sea/Persian Gulf, and *Poecilasma minutum* (Gruvel) from 7° 15′ 0″ N., 77° 46′ 0″ E. (143 fathoms); by Nilsson-Cantell (1938) for *Trilasmis amygdalum* (Aurivillius); and by Daniel (1956) for *Trilasmis minuta* (Gruvel), *Octolasmis lowei* (Darwin), *O. angulata* (Aurivillius), *O. tridens* (Aurivillius), and *O. warwickii* (Gray). *Poecilasma excavatum* (=*Trilasmis excavatum*) (Hoek) and an *Octolasmis* sp.

have also been more recently reported epizoic on the spiny lobster *Puerulus sewelli* Ramadan by Dinamani & Kurian (1961).

The spiny lobster 'host' mentioned by Annandale in all his records is '*Panulirus* sp.'. In case of *Poecilasma minutum*, however, he mentions it specifically as *Panulirus angulatus* (Alcock, 1901) which is identical with *Puerulus sewelli* Ramadan (Holthuis, 1946, p. 110). The host mentioned by both Nilsson-Cantell and Daniel on the other hand is '*Palinurus*' sp. The identification of the host genus as '*Palinurus*' in the Indian records of both Nilsson-Cantell and Daniel is apparently an error for *Panulirus.* The family Palinuridae is predominantly represented in the Indian waters by the genus *Panulirus,* while *Palinurus* is as yet known only from two uncertain records.

Bivalves. Ostrea (*Crassostrea*) *cucullata* Born. was found to be the only pelecypod associate of *P. polyphagus.* Both the instances of oyster spat settlement (Table I) are from Uran creek. Lobsters from deeper waters were always free from any bivalve settlements.

Tube-building Annelids. Only in two instances *P. polyphagus* from trawl catches had dead tubes of serpulids on its carapace and thoracic sternum. Much heavier incrustations of serpulids were present on many of the lobster moults washed ashore.

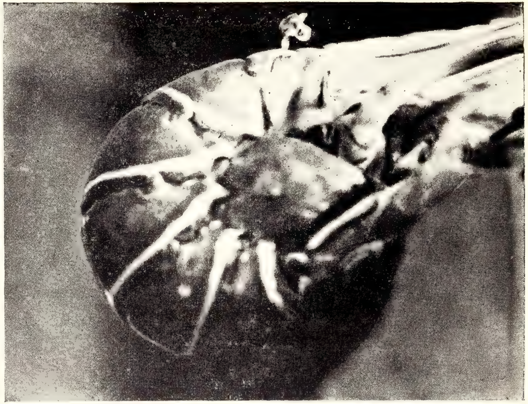
Coelenterates. Skeleton of the solitary coral *Balnophyllia* was found anchored on the carapace of a berried female *P. polyphagus* from deeper waters. The age of this coral, estimated to be around a year, indicated that this female had not moulted for that period. This lobster also had a *Balanus amphitrite* on the carapace.

Bryozoa. The incrusting bryozoan *Acanthodesia* was found on *P. polyphagus* once only. On the contrary, however, Dexter (1955) in the case of *Homarus americanus* registers bryozoa as the chief fouling organisms.

Relation between the Spiny Lobster and the Epizoa

In case of the American lobster *Homarus americanus* (M. Edw.) Herrick (1895, p. 122) remarks: '. . . . . the lobster is encumbered with a great variety of messmates which attach themselves to the

Epizoic associates of *Panulirus polyphagus* (Herbst)



(*Left*). Balanids on thoracic sternum of *P. polyphagus*;

(*Above*). Pedunculate Cirriped O. warwickii on *P. polyphagus*.

(*Photos*: *Author*)

external shell'. The epizoa specifically referred to by him and Dexter (1955, p. 160) are common barnacles, bryozoans, bivalves, tunicates, tube-building annelids, nullipores, hydroids, anthozoans, and sponges. It is interesting to note that compared to *H. americanus* much fewer varieties of epizoa settle on the spiny lobster *P. polyphagus.* This is possibly true of the Norway lobster *Nephrops norvegicus* also, although Barnes & Bagenal (1951) have in their paper focussed their attention only on the epizoan *Balanus crenatus* Brug.

It also appears that, in contrast to the higher epizoic incrustation percentage (unless the samples are highly selective) in the case of the American lobster (26% to 79%, Dexter 1955) and the Norway lobster (approx. 21% to 50%, Barnes & Bagenal 1951), in the common Bombay spiny lobster it is on an average as low as 1%. In a particular collection, whenever it possessed any epizoa the percentage of such 'hosts' in that collection varied between 2 and 20 (column 3, Table I). Spiny lobsters in all the remaining collections, on the other hand, were free from any macroscopic epizoa, suggesting that epizoic incrustations take place only under particular ecological conditions. From Table I it will be seen that the majority of these instances are confined to the larger specimens trawled off muddy flats under 30 to 70 metres. Environmental conditions here, such as larger surface area and retarded ecdysis frequency of the host, very slow currents in the neighbourhood, and possibly enough food, may be favourable for epizoic settlement and growth. The younger individuals, which are fished only in the inshore waters, are always free from any epizoa, obviously due to strong current action and higher ecdysis frequency.

Column five of Table I reveals an interesting sequence of favoured anchorage areas, the preferred sites being, carapace (79.59%), sternum (10.20%), abdominal terga (4.08%), antennae (4.08%), and the tailfan (2.04%). Females generally appear to be more 'susceptible' than the males, constituting nearly 62% of the total epizoa incidences, while in having only one epizoic species there does not seem to be any sex preference.

The epizoa certainly derive some advantage from their decapod host. Live acorn and goose barnacles anchored on the shell were always observed to be sufficiently quick to smell the fine food particles formed by the host during the mastication of the food offered. A very interesting instance of a balanid deriving noteworthy advantage from the decapod host is reported by Barnes & Bagenal (1951). They found that during late spring and early summer of

1950, high settlement of living *Balanus crenatus* Brug. covered a very vast surface area of inanimate objects in the Clyde Sea Area. In late summer the majority of this population had died out, while in contrast the barnacles epizoic on *Nephrops norvegicus* were living. They attribute this survival of the balanid to the protective action of either the host or its muddy bottom habitat. Any such advantage on the part of the epizoan would of course be lost after the host has moulted. The epizoic settlement in turn may provide a slight advantage of camouflage to the decapod host. It can be 'troublesome' to the host only rarely, for example in the case of a matured female *P. polyphagus* about to receive the spermatophores from the male and having a number of barnacles on its thoracic sternum (Plate, fig. 1).

Day (1935, p. 565) in the case of crabs remarks, '. . . crabs bearing barnacles and serpulid tubes have not much vitality . . .'. This, however, is never true of the spiny lobster *P. polyphagus,* and even in the case of crabs Day's statement cannot aways be justifiable as Foxon (1940, p. 260) has already pointed out.

While it is easy to imagine the larvae of sessile barnacles settling on the spiny lobster, the larvae of pedunculate barnacles such as *Trilasmis* and *Octolasmis* present some difficulty in that respect. Their mode of settlement on the spiny lobster is possibly linked with the predatory feeding habit of the host. While examining the stomach contents of trawl-caught *P. polyphagus,* I have at times come across fragments which presumably belonged to some pedunculate cirripeds. It is likely that such cirripeds, though commonly available on floating or moving objects, may under particular conditions form small colonies on the substratum in deeper waters and thus be an item on the menu of some decapods. When offered experimentally, pedunculate barnacles are readily accepted as food by spiny lobsters. It is then quite possible that, while these organisms are being devoured by the spiny lobsters, their larvae get forcibly released and a settlement ensues on the host, which is in close proximity.

Dinamani & Kurian (1961, p. 149), considering the higher incidence of *Trilasmis excavatum* settlement on the ventral aspects of *Puerulus sewelli,* remark: 'The concentration of juvenile and young cirripeds at these sites probably indicates the mode of infestation of the lobster. It is possible that the larvae of these cirripeds, released at cypris stage and with limited powers of swimming, remain close to the bottom. As the lobsters crawl about, the ventral side of the body, which is closest to the substratum, presents a suitable place for

affixation to the cirriped, especially at sheltered regions like the base of the pereiopods within the margin of the carapace'. The larvae of *Trilasmis* and *Octolasmis* (these, incidentally, are released at the first naupliar stage and not at the cypris stage) are more successful in effecting settlement on the ventral sides of the host because of the comparatively higher protective action of these sites and not due to the proximity of the ventral side of the host to the substratum as imagined. Whether it is ventral or dorsal side of the host would otherwise make no difference, since the height of the host is not considerable.

In addition to the protective action of the host, some other factor, presumably inherent in the pedunculate barnacle, seems to be necessary for successful settlement. It is interesting to note in this respect that, while numerous instances of the species of the genera *Octolasmis* and *Trilasmis* are reported epizoic on deep water palinurids, the species of the deep water genus *Scalpellum* are not yet known to occur in a similar association.

Summary

Epizoic associates of the spiny lobster *Panulirus polyphagus* (Herbst) are described; sessile and pedunculate cirripeds were found to be the commonest.

Inter-relationship between the epizoa and the host is discussed.

Acknowledgements

The author wishes to express his sincere thanks to Dr. C. V. Kulkarni, Director of the Maharashtra Department of Fisheries, and Dr. H. G. Kewalramani, Senior Scientific Officer, T.M.B. Research Station, Bombay, for critically going through the manuscript.

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A Report on the Gecko *Teratolepis fasciata* (Blyth, 1853)

BY

JER. AND. ANDERSON

Collector and Field Associate, Royal Scottish Museum, Edinburgh[1]

(*With two plates, one map, and three text-figures*)

INTRODUCTION

Very few records exist of the occurrence of *Teratolepis fasciata* (Blyth, 1853) since Smith's comprehensive report on the species in Vol. II of FAUNA OF BRITISH INDIA, REPTILES. Between 1952 and 1962, 12 specimens were collected in lower Sind by M. G. Konieczny for Prof. Robert Mertens of the Senkenburg Museum. The Karachi Zoo obtained three specimens from a local collector in 1953-54 and Dr. Sherman Minton Jr., of the American Museum of Natural History, obtained a female from Thatta in June 1961 which laid 2 eggs in the terrarium (the eggs subsequently hatched). He obtained a a second adult from Mirpur Sakro the following year.

Between 1 December 1961 and 1 May 1962 intensive collection of this species was organized by the author in the Indus Delta flood plain particularly at Thatta, Pir Patho, Gora Bari, Sujawal, Jathi, Badin, Shah Bunder, and Mirpur Sakro. Collecting was mainly at night and about 200 specimens were caught of which approximately 70% were adult males. The percentage of specimens with regenerated tails was: Thatta (*c.* 80%), Pir Patho (50%), Jathi, Badin, and Mirpur Sakro (20%). The results provide adequate evidence that the species is not uncommon, though patchily distributed in the Indus Delta plain. These areas of abundance are referred to as Colony Sites in this report.

RANGE

The Indus Delta plain (Sind: West Pakistan) from the eastern limits of the lower Persian plateau region to the western perimeters

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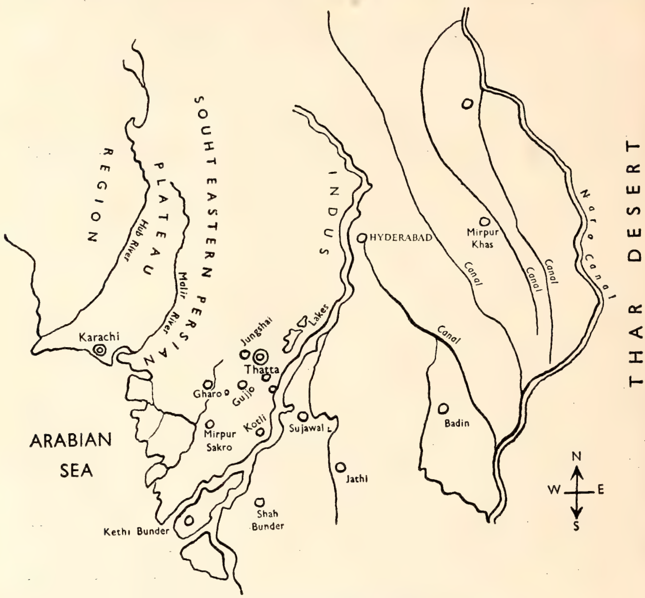
[1] Present address: c/o The French Military Attache's Office, 20/E Drigh Road, Pechs, Karachi 29, W. Pakistan

of the Thar desert, at sea-level more or less; bounded in the south by the coastline; limits north of latitude 25° not recorded. Records



Sketch Map of the Indus Delta Plain

of occurrences beyond these limits require substantiation. It is likely, however, that the species occurs on or around delta plains of the Ganges and other Indian rivers.

Collection Site : Raj Malk, district Thatta, Area Mirpur Sakro, December 1961

The site of collection is an 18th century burial ground covering about 5 acres, situated at the western edge of the Indus Delta area between the villages of Gharo and Mirpur Sakro and about 6 miles from the coastal marsh along Gharo creek. The terrain is flat with an average elevation of less than 10 ft. above sea-level. The soil is loose grey sand and silt. The area is affected by salinity. The dominant vegetation is desert scrub, particularly *Salsola foetida* and

grasses. Two shallow lakes lie alongside the site. The graves are overgrown and dilapidated. Loose bricks measuring about 200 mm. square and 30 mm. thick lie scattered all over the ground intermixed with larger stone slabs dislodged from the graves. A 5-ft. brick wall, also dilapidated and wind-worn, surrounds two large mosques in the centre of the site: the square thus formed is about 800 sq. yards. A village of about 25 huts with an over-all population of 100 lies on the side of the site and a regularly used cart road winds through it. A programme of mechanized cultivation is under way all around the site.

Holes of small gerbilles are numerous and the terrain around the walled-in square is uneven and colonized by the brush-tailed *Meriones hurrianae.* Other mammals identified are hare, jackal, mongoose, fox, porcupine, hedgehog, and shrew. Birds are numerous and include hawks, shrikes, owlets, crows, rollers, mynas, and babblers, among the possible predators. Other reptiles seen or collected at or near Raj Malk include, *Hemidactylus brooki, persicus,* and *flaviviridis, Gymnodactylus kachensis, Eublepharis macularius, Mabuya macularia, Acanthodactylus cantoris, Calotes versicolor, Agama agilis, Varanus monitor, Psammophis leithi* and *schokari, Coluber fasciolatus* and *ventromaculatus, Oligodon taeniolatus, Spalerosophis diadema, Natrix piscator, Naja naja, Bungarus caeruleus, Vipera russelli,* and *Echis carinata*—all relatively common and widely distributed species. Another uncommon species collected at the site is the small Blind-snake *Leptotyphlops blanfordi,* represented by two specimens. The only amphibians immediately associated with the *Teratolepis* are *Bufo andersoni* and *Rana tigrina.*

All the *Teratolepis* collected at this site were found by day beneath cover lying on loose, dry soil. More were found under small bricks than elsewhere. Two of those collected were large adults (body 60 mm., tail 35 and 40 mm.), 6 average-sized adults (average body length 50 mm., tail 25 mm.), and one juvenile (body 28 mm., tail 14 mm.). Excluding the juvenile, the collection consisted of 2 males and 6 females: both the large specimens were females. Two out of the 9 had regenerated tails.

Descriptive notes

Rostral with median cleft above: 7 to 10 upper and 6 to 8 lower labials. Scales on head roundish, convex, granular and subimbricate on parts. Dorsal scales strongly imbricate, smooth on neck and feebly

keeled on back, graded backwards, smallest on neck and largest on rump. Caudal scales strongly imbricate, leaf-like and large, as wide as diameter of eye, with faint striations. These large scales begin from the constriction at the base, the largest in the middle and the smallest at the tip. Greatest circumference around tail more than greatest circumference around head or body. Tail so constructed as to permit only entire dismembering from constriction at base, never partial. Hence regenerated tails are always entire, never in portions. The regenerated tail is more swollen and quite circular in cross-section, heart-shaped. The imbricate scales are smaller and the original colour and pattern replaced by irregular mottling. Regeneration takes about ninety days under favourable conditions.

Subdigital lamellae: forefoot—7, 8, 9, 9, and 8 lamellae; hindfoot —7, 8, 9, 9, and 7 lamellae. Lamellae pads separate from one another but on common basal plates, most of which are notched, the first and last two or three entire.

Post-anal sacs large and prominent in males, absent in females, and post-anal bones present. Males with six to eight pre-anal pores. Maximum length recorded: head and body 65, tail 40 mm.; average length: head and body 50, tail 31 mm. Males are generally smaller than females.

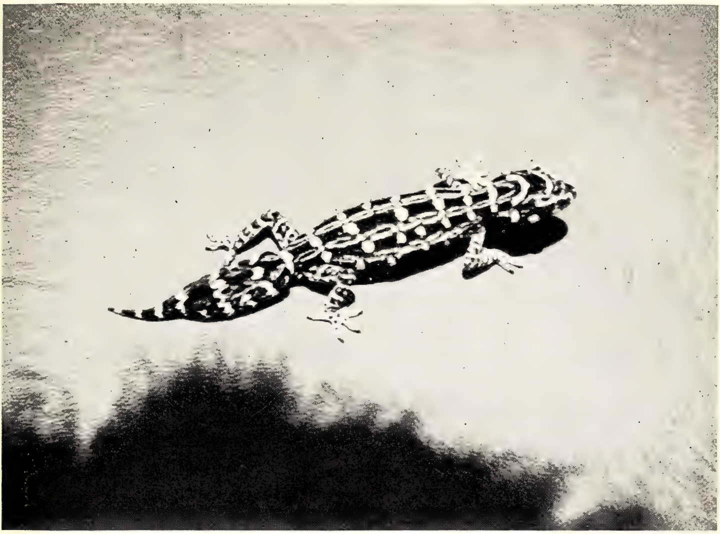
Colour and pattern are regular and constant in all specimens, from newly hatched young to adults. The only recorded variations are in colour shades, which are generally temporary, and in precise shape and extent of white markings. Each scale is of only one colour as a rule and the white spots and bands comprise groups of white scales. Mental with a median dark brown line, corresponding with rostral cleft. Coloration in aged specimens tends to fade and the pattern becomes slightly blemished.

The skin is thick and tough, of velvety quality, and the pattern stands out boldly. Sloughing takes place roughly every 40 days and the shedded slough bears the original colour and markings distinctly, though translucent.

Habits in the field and in the terrarium

When discovered, the geckos immediately curl up with the tail coiled and pressed inwards against the side (Fig. 1). On further disturbing, they depress their bodies, flattening out, head bent tightly against one side, and raise the tail erect and on edge presenting it like a shield towards the assailant (Fig. 2). Still further provocation

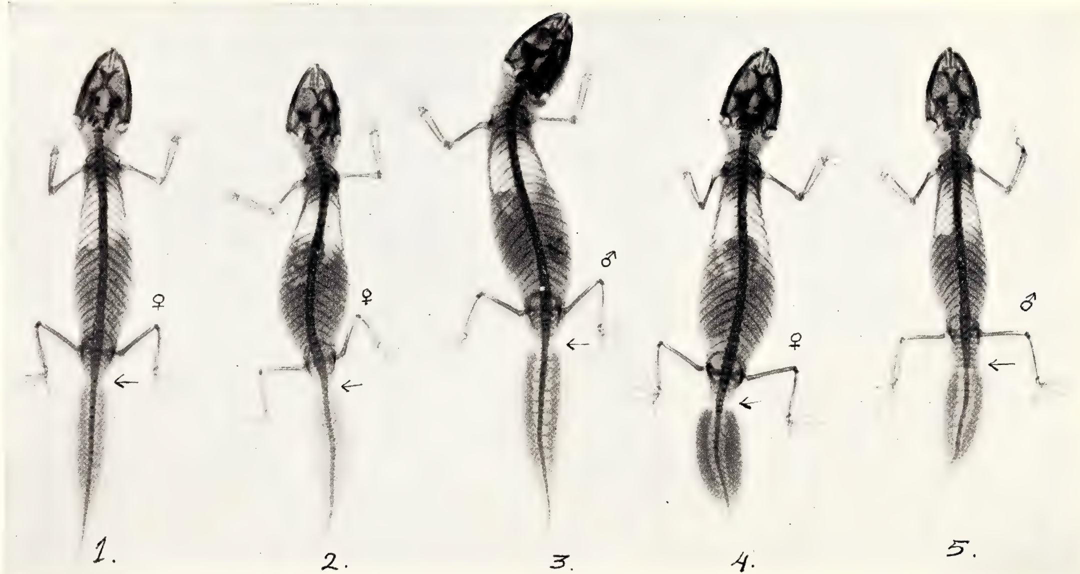
Teratolepis fasciata (Blyth)



At rest

In defensive posture

Photos : Dr. Sherman A. Minton, Jr.



X-Ray photographs of *Teratolepis fasciata*

Nos. 1 to 3 original and 4 to 5 regenerated tails. Breakage point, between 6th and 7th caudal sections, indicated by arrows. Regenerated tail has highly developed, sectioned cartilage column and original muscular development, which allow regenerated tail when broken the same nervous and muscular reactions as an original tail.

Photo : Dr. Ian Whimster

causes the geckos to arch their backs, rise on their legs, twitch their tails in sideward jerks, the top half swaying from side to side, and suddenly strike out at the assailant, with the mouth closed or open, uttering a raspy hiss barely audible to human ears. The tail is held high and directed towards the assailant until the instant of striking when the head shoots forward. The strike and demonstration may be repeated twice or thrice before the gecko scurries away swiftly in spurts for a metre or so at a time. When handled, the geckos coil up tightly, tail bent over on one side and head in towards tail tip (Fig. 3), and this position is relentlessly maintained until such time as the gecko becomes used to handling.

Fig. 1. Fig. 2. Fig. 3.

Teratolepis fasciata (Blyth)

Fig. 1. When first discovered; Fig. 2. When further disturbed; Fig. 3. When handled.

They show no inclination to climb the heavy, rough bark of a large tree or to hide in its available crevices, but will readily climb narrow limbs of bushes and on to the branches and will scale a worn brick wall and make for chinks, holes, and crevices hastily.

They will swim 2 metres of water in about 10 seconds showing a regular style of swimming, turning and twisting the body with the apparent assistance of the tail in a serpentine manner. When walking on a smooth, hard surface, the geckos move very slowly and deliberately, curling each toe up until the nail touches the ankle as they lift their feet. They lick the surface at intervals as they advance.

Teratolepis in terrariums show a tendency towards communal latrine habits, usually depositing all excreta in a specific part of the terrarium.

Excluding the rough tail portion, which is discarded, the shedded slough is eaten by the gecko.

In the terrarium, specimens shovel away sand to gain better entrance beneath a stone or some such object and thus create comfortable forms. Individuals of both sexes have been observed shovelling earth backwards with both fore- and hindfeet, apparently aimlessly while gazing fixedly and blankly or when approaching another specimen, occasionally during breeding, in the manner of dogs. However, at no time have they shown the tendency to actually excavate their own burrows when suitable soil has been provided. When kept among other small burrowing geckos, like *Stenodactylus* and the American *Coleonyx*, which efficiently and promptly made their own burrows, the specimens never entered these burrows not even when the occupant was abroad. Instead they would lie beneath a leaf, behind loose bricks, or high upon the limbs of dry branches or the walls of the terrarium.

Injurious breaks to the skin take a long time to heal and scars are left for life. A wound on the foot of a young specimen took about 90 days to heal during which time sloughing took place on two occasions shedding from around the wound. During this period the specimen increased in length by 5 mm.

In their attempt to escape capture, males will actually turn ferociously upon their assailant, hiss, arch the back, strike out with both mouth and raised, coiled tail, and flee in leaps and bounds actually jumping between 20 and 40 mm. high, covering some 30 to 50 mm. in distance at each leap. The flight is in rapid, short, spurts, the tail being withdrawn into the usual tight coil at each halt. When aggravated and prevented from escaping, they will flip their entire body length sidewards, to and fro, in quick jerks, twitching head and tail sidewards alternately in co-ordination with each flip, hissing simultaneously. One male specimen bit a probing finger very sharply and held on until it broke the grip, seemingly by twisting the tail over its mouth. Sometimes the caudal scales are slightly raised, individually, in lateral series, or all together to produce perhaps yet another effect. Females are very lethargic and require considerable provocation before any reactions are obtained. Some refuse to react at all.

Experiments and observations

A young *Coluber ventromaculatus*, a snake known to feed off lizards largely, was introduced into a terrarium containing eight freshly collected *Teratolepis*. Four of the geckos reacted by flatten-

ing head and body to the sand, twitching their tails in the air, in the already described manner, and thrusting it in the direction of the serpent's head. They then struck at the head and scrambled away, still flattened to the sand, twisting and turning in a zigzag manner as they fled. One large gecko struck the serpent's head with open jaws but did no apparent harm. All four lizards turned very pale in general colouring which then tended to blend more with the sand. The remaining four *Teratolepis* in the terrarium, which were comparatively out of the way, merely curled up in their corners. For an hour or so after the experiment these geckos would react in an identical manner when provoked with a finger tip or stick. Introduction of a medium-sized *Eublepharis macularius* fat-tailed gecko (roughly 6 times the size of a *Teratolepis*) into the terrarium a couple of hours later induced similar reactions in the *Teratolepis*. Both the *Coluber* serpent and *Eublepharis* gecko showed signs of fright during the experiment. During the night, some 5 or 6 hours later, five of the specimens were clinging to the wire netting sides of the cage or perched on pieces of wood instead of in their usual position on the floor of the terrarium.

Specimens assumed coiled positions with their upper tail surface facing the entrance like a shield after being left undisturbed for 30 minutes or so in provided form or burrow.

When submerged 200 mm. in water, specimens surfaced apparently calm at approximately 45° angle.

Specimens buried under 100 mm. of loose, soft sand did not attempt to get out until provoked with a stick but remained thus for about 15 minutes and then surfaced easily shovelling the sand backwards.

When introduced to a flat vertical wall surface of uneven and weather-worn bricks, specimens climbed with apparent ease and followed joins to crevices which they entered.

They were able to cling to the lower side of a polished glass surface held at an angle of 60° to the horizontal, and move each foot individually in this position. They held fast to the completely inverted surface of some medium grain cardboard, even when gently shaken.

Reproduction

Courtship takes place between February and June, but tends to continue further and seems to carry on to a lesser degree right through the summer.

The mating call is four, clear, loud and short clucks (as of *Hemidactylus*) followed by a prolonged rolling trill, which lasts for a duration of about five seconds. This is repeated at regular intervals of about 10 seconds for approximately half an hour. The calling may be continued. The responsive female call is similar but of a much lower tone.

The male approaches the female slowly and deliberately, either with body flattened or raised high on its legs, with tail raised erect, gracefully swaying from side to side and twitching at the base. The female responds to the approach similarly but with somewhat reserve. Before attempting copulation, the male licks the head and body of the female several times, whilst cautiously stalking around her, apparently for responsive reactions. Sometimes a female resists and is then run down and overpowered, her neck or head grasped in the jaws of the male who forces her to the ground and compels her to submit.

Often two males will fight savagely over a female and a tail of one or other is sometimes snapped off.

Out of a specially segregated collection of 40 males and 30 females, 27 females laid 135 eggs from March to June and 68 eggs over August until 2nd September. Three adult females remained apparently barren. Eight more eggs were laid by the end of September, after which laying ceased. This made a total of 211 eggs laid from March to the end of September by 27 females. The maximum number laid by a single specimen was 24 and the minimum 2. The eggs were laid in clutches of two. The larger number of eggs were laid by the comparatively larger specimens and the lesser numbers by the smaller, apparently depending on the stage of maturity of the individual. Clutches are laid at intervals of approximately 14 days. The eggs of a clutch are laid one after the other, the interim period extending from 2 to 48 hours roughly. By 1st December 180 young had hatched out in perfectly healthy condition, while 31 eggs were spoiled, apparently not due to infertility. Incubation on the average took between 6 and 8 weeks.

An apparently aged female specimen with regenerated tail (head & body 61 mm., tail 22 mm.) out of the Raj Malk collection (collected 24th December 1961) was kept in a terrarium with 2 males, 1 juvenile, and 5 other females. Gravidity was first noticed on 22 February 1962. The first egg was laid on 5th March and the second on 7th March, behind a wall of loose miniature bricks on the sandy floor of the terrarium (measurements of eggs 9.5 and 10.5 mm. $\times$ 8 mm.). The specimen showed considerable concern for her eggs and when they were exposed by the removal of the brick

wall she tried to safeguard them by making every effort to cover them with sand by shovelling backwards with her forefeet. When the eggs were removed to the opposite side of the terrarium, she followed them, licked them several times, and continued her efforts. After the eggs had been placed in a ventilated plastic container (transparent) which was kept on the floor of the terrarium, the specimen made efforts to enter the container for the following two days. It finally resolved itself to coiling up on top of the container and lying there for the next ten days, only leaving it occasionally to relieve herself and feed and drink, before giving up. (The second clutch was laid on 22nd March.)

The first young hatched in the early hours of 4th May and the second on 6th May. They were kept in a container with some *Microgecko* and some newly hatched *Gymnodactylus* and *Hemidactylus*. On introducing the mother specimen she immediately went up to each of her young and licked them several times. She repeated this performance several times, walking about in circles and coming back to them from time to time. When she perceived a young *Gymnodactylus* she promptly grabbed it and devoured it. She did the same with a second and then returned to her young to lick them again.

In the field pairs of eggs have been found in deserted burrows, beneath piles of old bricks, and beneath large embedded stones etc. In the terrarium, with an exception of a few which were laid between and upon bricks, all the eggs were laid upon the floor and covered over loosely with sand. Single or more clutches were laid in the same spot. Specimens showed a tendency to choose and maintain a laying spot.

The eggs are a pure soft-white colour, hard-shelled and fragile, and generally of an oval shape though sometimes perfectly round. Sizes and shapes vary considerably, pairs of a clutch being almost identical usually. The irregularity in egg dimensions of the species is most marked. An example of size irregularity in the eggs of one specimen laid consecutively in one season is as follows: 9.5×8 and 10.5×8 mm., 10×9 and 10×9 mm., 11×8.4 and 11×8.6 mm., 10×9 and 11×9 mm., 11×10 and 11.5×9 mm. A pair of round eggs laid in a clutch measured 8.8×8.8 mm., each. The largest eggs recorded measured 11.5×10 and 11.5×10.5 mm.

Average measurements of newly hatched young: head and body 22 mm., tail 12 mm.

Feeding

Teratolepis in captivity feed readily off all arthropods. Crickets, roaches, hoppers, and worms are relished. Newly hatched young thrive off termites and grubs. All arachnidae, including scorpions dangerous to man, are taken and I have observed a small black scorpion pierce the forehead of a gecko with its sting (about $2\frac{1}{2}$ mm. long) whilst being eaten, causing no apparent harm whatever. As a general rule, young geckos of other species are not taken and when this does happen the undigested body of the young gecko is usually regurgitated an hour or so later. Specimens in the terrarium show a marked thirst and frequently lap water out of an open dish.

Conclusion

To laymen and herpetologists alike, the most striking feature of the *Teratolepis* is the large, thick, flat tail with its unusual, leaf-like scales. While doubtlessly functioning as a store of surplus fat for times of need, the tail also seems to play an important part in the defence of the gecko against its enemies. It is a threat, a shield, and finally a sacrifice to the potential predator. While it is always hazardous to try to speculate on just what it is that a small predator sees when confronted with such an animal, it appears to human eyes that the tail of the *Teratolepis*, particularly as the gecko lies in its dwelling or form, may resemble a bent segment of a coiled serpent, more specifically the ubiquitous and dangerous viper, *Echis carinata*, which infests the flood plain. The illusion created by its defensive movements and hissing lends itself to this semblance and the mimicry seems quite perfected. In this respect specimens with regenerated tails tend to act the mimic with somewhat more vehemency and perfection. The experience of having lost its tail once may account for this. However, in these cases it was observed that the geckos abandon the initial act very promptly and resort to the tail offering almost instantly. A regenerated tail is very roundish and does not present the same illusion as the original.

The collection locality, Raj Malk, chosen in this report to describe habits, results of field experiments and observations, and environment, etc., is typical of all known *Teratolepis* Colony Sites on the Indus Delta flood-plain.

The absence of man-made structures on such Colony Sites seems to have but one outstanding example, that of Makli Ridge which

influences two known sites Kalan Kot and Pir Patho. However, even at these sites there are remnants of ancient human structures, though they actually do not influence the sites as much as the ridge itself. This rocky edifice rises rather abruptly out of the plain to a mean elevation of 100 ft. or so and is a finger of the Persian Plateau, stretching out across the plain for some 35 miles from Jungshai almost to the very banks of the Indus river. Some 25 miles north of the Makli Ridge other similar, though broken and disjointed, ridges extend right on to the banks of the river. These, I feel, form the northern boundary of the population of the plain on the east bank.

Acknowledgements

I thank Dr. Sherman A. Minton, Jr., Research Associate to the American Museum, my Professor and colleague, without whose continuous guidance this paper would not have been possible; Dr. A. Rahman Ranjha, Director, Zoological Survey Department of Pakistan, for allowing me access to the Department's voluminous library; Mr. Arthur S. Clarke, of the Department of Vertebrate Zoology, Royal Scottish Museum, for his critical advice and taxonomical data; Miss Alice G. C. Grandison, Curator of Herpetology, British Museum, for photostat copies of some important literature; and Mr. M. G. Konieczny, for his opinions and critical comments from time to time.

Reviews

1. THE SCIENCE OF ANIMAL BEHAVIOUR. By P. L. Broadhurst. pp. 135 (18 × 11 cm.). 8 plates. Harmondsworth, 1963. Penguin Books. A Pelican Original, A629. Price 3*s*. 6*d*.

This brief introduction to the study of animal behaviour covers a great deal of ground in its 135 pages. It deals clearly and concisely with scope, methods, and aims. Its style, however, tends to be rather too condensed for easy reading, each paragraph dealing with a new concept which needs to be digested before one moves on to the next. Some of the material is familiar. We meet Pavlov's dogs, and rats which run through mazes or press levers; but we meet them in perspective. And some of it borders on science fiction—how many people are aware that pigeons can be trained to do postal sorting, or to guide missiles to their target?

Some of the most interesting studies have been made on monkeys. The charming baby rhesus monkey who is seen on the cover clinging to a terry-towelling 'mother' prefers a towelling dummy to a wire one, though it was fed from the wire one. Monkeys like this one, deprived of mothering in infancy, grow up into adults which take no interest in sex—mothers are obviously necessary for normal development. Again, monkeys can be made to develop ulcers by undergoing stress. A group of monkeys was taught to press a lever in order to delay an electric shock. These monkeys developed ulcers, whereas another group which was shocked frequently but was given no chance to avoid shocks did not develop ulcers. Anxiety, therefore, was more due to the necessity for keeping the current switched off than to the unpleasant experience itself.

Too facile comparisons between animal and human behaviour have to be avoided. By subjecting animals to unpleasant experiences as they are about to feed, 'experimental neuroses' can be produced in which the animals will not feed and show signs of emotional upset. This looks at first like human neurosis, but unlike it the behaviour does not persist in fresh situations and places. Moreover, human neurosis is harmful to the individual whereas a refusal to feed is the most sensible thing for an animal to do in a situation where an attempt to feed provokes an unpleasant shock.

R.R.

2. PREHISTORIC LIFE ON EARTH. By Kai Petersen. Edited, adapted, and supplemented by Georg Zappler. Illustrated by Verner Hancke. pp. 163 (22.5×16 cm.). London, 1963. Methuen & Co. Ltd. Price 21*s*. net in U.K. only.

The title indicates what a tremendous span of life the author had to cover in this book. In consequence the sections of the book covering the period from life's beginning to the reptilian epoch are a bit too crowded with facts. But the sketches and diagrams which adorn almost every other page help a great deal in explaining and enlivening the text. This book is one of the excellent series to which belongs BIRDS OF THE WORLD by Hans Hvass reviewed in Vol. **60**, No. 3, p. 713 of the *Journal*, and of which another REPTILES AND AMPHIBIANS OF THE WORLD is under preparation.

As is quite understandable, the religious view about the creation of the world and its inhabitants was not easy to displace, even in the face of facts which kept accumulating in support of the more rational theory of evolution. As late as 1776 the fossil of a giant salamander was considered to be 'the remains of a poor sinner that drowned in Noah's flood'. By the time that Georges Cuvier wrote on the comparative anatomy of fossils in the beginning of the nineteenth century and showed the connection between one extinct form and another, the scientific view had made a considerable dent in the religious theory. But Cuvier too was convinced about the immutability of the species and relied on the theory of 'catastrophe' to explain away gaps in the evolutionary chain. Doubts about the accommodation problem in Noah's Ark kept cropping up, and Lamarck in his PHILOSOPHIE ZOOLOGIQUE was the first professional zoologist to accept evolution wholeheartedly. This was in 1809. He had, however, put forward some curious theories. For instance he believed, that giraffes had long necks because the ancestors of these species had continually to stretch their necks in search of high foliage. This statement was disproved conclusively only by later researches. Another important landmark was the publication of Charles Lyell's book PRINCIPLES OF GEOLOGY in 1830. He established for the first time the tremendous time scale involved between one geological stratum and another. The variation in fossil forms could be understood in terms of changes that took place over millions of years, but had seemed improbable when a smaller time scale was visualized. In 1859 Darwin published his epoch-making book ON THE ORIGIN OF SPECIES BY MEANS OF NATURAL SELECTION, but such was the hold of the religious view even on his scientific mind that he

deliberately made no reference to the origins of man. He wrote about this delicate subject only in 1871 in his DESCENT OF MAN.

The author points out in the earlier part of the book that it was fortunate for Darwin that Mendel's paper published in 1865 did not draw too much publicity. Mendel, by his experiments in cross fertilization of coloured peas, proved the immutability of inherited characters lodged in the genes. If this meant that there could be no variation of the species by natural selection, Darwin's entire approach would have fallen to the ground. In good time, however, the work of the Dutch botanist, Hugo de Vries, demonstrated that mutations did take place from time to time entirely at random. This was enough to sustain the theory of natural selection, and of the survival of the best-adapted form at any particular time.

It is difficult to say when exactly a non-living molecule becomes a living entity. Apparently, at the level of the atom there is no difference between it and the non-living environment. The difference comes at the large molecule stage. The book traces in a detailed manner the various stages of life from the state of inorganic molecules to that of the mammals.

From the point of view of the general reader like this reviewer, the most interesting portions of the book are those which describe evolution at the cross-roads. For instance during the Permian Era, when the amphibians were on the scene, many species were struggling to overcome the handicaps of terrestrial living. Evidence of life in those times is necessarily scanty, and to this day it is not possible to say for certain whether *Seymouria* was an amphibian or a reptile, but the discussion gives one a good insight into the type of problems which creatures had to face at that time. As is well known, the reptiles made very fast progress during the Mesozoic Era about 200 million years ago. The three periods of this era, the Triassic, Jurassic, and the Cretaceous bring the story to 70 million years from today. This was the period when the reptiles dominated the world. The coloured illustrations by Verner Hancke show the monstrous and terrible forms (at least to our eyes) that populated the world at the time. By the process of mutation and selection the first bird *Archaeopteryx* evolved from these ungainly animals. At this stage evolution took a reverse trend. Forms which had struggled for centuries to adapt themselves for living on dry land and finally succeeded by developing the 'patent' of the amniote (reptilian) egg were now striving to get back into a wet medium. When they first came from the ocean on to dry land they had to contend with problems of dessication and gravity. Now, when they wanted to get

back from dry land to the ocean, they had to face the challenge of buoyancy and propulsion. It also became necessary for them to produce live young.

At the end of the Mesozoic Era the Mammals took over. What led to the complete extinction of the giant reptiles is an unsolved mystery. Large bodies and small brains seem to have been the obvious cause—a lesson which we humans should remember. The story naturally ends with ourselves. 'We are neither the beginning nor the end. The thread that has wound and twisted its way from the first glimmerings of life is still unravelling.'

Z.F.

3. FIFTY YEARS OF SCIENCE IN INDIA : Progress of Botany. By P. Maheshwari and R. N. Kapil. pp. vii+178 (24.5×16 cm.). Calcutta, 1963. Indian Science Congress Association. Price Rs. 4.50.

Coming at a time when advancement in different branches of botany is so rapid, it is becoming increasingly difficult to keep track of all the new findings. The volume under review, prepared on the occasion of the Golden Jubilee celebration of the Indian Science Congress and covering progress in different branches of botany in the last fifty years with special emphasis on the past twenty-five years, is a welcome addition to botanical literature. The mass of information accumulated during the period, however, is so great that to quote from the preface: 'To review all this would be impossible for two persons. The present treatment is, therefore, rather broad-based and deals with only the most important and significant aspects of Indian botany.'

A glance at the contents is sufficient to give an idea of the wide scope of the work. After a brief introduction the authors deal with such topics as Algae, Fungi and Allied Organisms, Bryophytes, Pteridophytes, Gymnosperms, Taxonomy, Morphology and Anatomy, Embryology, Cytogenetics, Plant Breeding, Ecology, Physiology, and Paleobotany. Salient features from all the important papers in these branches are presented cogently. They are based on 817 research papers, references to which are given under 'Literature Cited'. Further, the inclusion of many elegant illustrations in the form of line drawings and photographs enhances the value of the work.

Of special merit is the chapter on General Considerations, where the authors have rightly stressed the importance of starting a National Biological Laboratory in India. Biological sciences have acquired a greater importance than ever before and the need for starting such a laboratory cannot be overemphasised.

The book will be an invaluable acquisition to libraries of educational and scientific institutions engaged in botanical and agricultural researches.

K. SUBRAMANYAM

4. NERVE CELLS AND INSECT BEHAVIOUR. By Kenneth D. Roeder. pp. 188 (22×14 cm.). With several monochrome photographs and line drawings. Cambridge, Massachusetts, 1963. Harvard University Press. Price $ 4.75.

Insect neurophysiology is important, according to Dr. Roeder, because it is part of general neurophysiology. We know a great deal about the way the nervous system works, mainly from work done on mammals. Much less is known about the insect nervous system; but, in general, impulses are generated and conducted along axons (or nerve fibres) in the same way. The system consists of relatively few cells, so individual parts can be more easily isolated and studied. This also means that insect behaviour depends on fewer units than in vertebrates, so that the neural mechanism underlying behaviour can be more satisfactorily related to behaviour pattern.

An example of this is seen in Dr. Roeder's studies with the tympanic membranes of Noctuid moths. These are large oval membranes on either side of the thorax, serving as ears. Each tympanic membrane has two sense cells, and the auditory nerve therefore contains only two axons. High pitched sounds, for the most part beyond the range of the human ear, cause electrical impulses to be generated in the sense cells and to be conducted along the auditory nerve. Activity in the nerve can be detected by inserting a tiny electrode into it. Current pulses at the electrode are amplified and either recorded on a chart as a pattern of spikes or made audible by a loudspeaker as a series of clicks. A preparation of this kind was exposed to bats flying overhead, their cries being inaudible to human observers. Activity in the auditory nerve was followed continuously with oscilloscope and loudspeaker.

This is Dr. Roeder's account of 'the high excitement of listening for the first time to these night sounds through a moth's ear': '. . . the first indication of an approaching bat was a change . . . from an irregular sequence to a regular burst (of clicks) at ten per second . . . The bursts appeared to rise in pitch and change in quality, then to go through the reverse sequence and die away. This was interpreted as the approach and departure of one bat . . . Other patterns soon became recognizable. (In one of these) each burst is very long, and some appear to be double. These were undoubtedly evoked by a bat flying very close to the preparation, and the only explanation of the second . . . burst is that the moth's ear detected not only the bat's chirp but also its echo from a nearby wall . . . It is interesting to listen through stereo headphones to the taped responses of right and left tympanic nerves to a moving bat. The human ear interprets these spike differentials as giving direction to the source, and one can almost imagine oneself inside the nervous system of the moth as the source of clicks appears to move from one side to the other.'

What does a moth do when it hears a bat? The reactions of intact moths to ultrasonic impulses were watched. Moths some distance away from the transmitter would turn and fly away from the source of stimulation, but those within ten feet would dive into the grass, or execute a complicated and unpredictable series of manoeuvres before diving. The survival value of such behaviour is evident.

I have described these observations at length because I think that only an example can give an idea of the unique approach to insect behaviour which is being made here. The rest of the book is equally fascinating. One of the most interesting chapters is on activity occurring in nerves in the absence of stimulation, a widespread phenomenon. There appear to be several behaviour patterns built into the nervous system, and which of these will appear at any given time is determined by the brain.

The book is very well arranged, and the argument is logically developed through chapters on diverse subjects. It should be read by everyone interested in insects or in neurophysiology. It is not every day that a physiologist as distinguished as Dr. Roeder writes a book which is so clear that it can be read by people with very little background in the subject, and yet which will make many professional scientists think.

R.R.

5. THE NATURE OF ANIMAL COLOURS. By H. Munro Fox & Gwynne Vevers. pp. 246 (22.5×14.5 cm.). 9 Coloured plates. London, 1960. Sidgwick and Jackson Limited. Price 42*s*. net.

There are weightly tomes on the value of its colour to an animal, whether as protection or warning, or as a stimulation factor. This book describes the nature of the colour, its origin, and its physical and chemical composition and character.

The book gives an illustrated and easily understood account of the two basic types of animal colour, structural colour and pigment colour. Structural colour results from interference, diffraction and scattering of light by the physical characters of the surface of the animal—the iridescence of the wing of an insect and the metallic brilliance of many beetles and of bird feathers, for instance, are interference colours, where the nature of the surface cancels out part of the spectrum and makes the balance visible. The non-iridescent blues of feathers are similar to the blue of the sky, and are due to Tyndall scattering of the shorter waves in white light by minute particles, which in feathers are air-filled cavities in the barbs. The green colour of feathers, frogs, and lizards is a combination of structural and pigment colours, the light before and after scattering passing through a filter of yellow pigment. Pigment colours like melanin and carotenoids are described in detail. Melanin, the black pigment of animals, is a stable compound, as instanced by the ink of fossil squids which has been used to sketch with 150 millions of years after the life of the animal! The carotenoids which give the pinkish tint to the wings of the flamingo are also responsible for many of the yellow, orange, and reddish colours. Incidentally, the flamingo derives its pigment from the blue-green algae it consumes and, to retain the colour, captive specimens are fed on cockles and mussels which are known to store carotenoids. These and a wealth of other details on various other pigment colours are covered in the first eleven chapters, which are rounded off with a chapter on laboratory work, a brief synopsis of animal colours, and an exhaustive bibliography.

The book is of excellent value to the student of zoology as well as others interested in knowing the reasons behind the colours, magnificent and otherwise, that exist in the Animal Kingdom.

J.C.D.

Miscellaneous Notes

1. OCCURRENCE OF THE RUSTY SPOTTED CAT *FELIS RUBIGINOSA* GEOFFROY IN SOUTH GUJARAT

It might interest readers to note the occurrence of the Rusty Spotted Cat *Felis rubiginosa* Geoffroy in south Gujarat. The northernmost record of the range of this cat hitherto recorded was south of Nasik.

I have collected two specimens, one in Dangs District and the other in the adjoining forest of Bansda Taluka (Surat District). One of the skins was identified by the Bombay Natural History Society and is kept in the Society's collection. The other is mounted in the museum of St. Xavier's High School, Bombay.

In an article by Mr. Gee in the April 1963 issue of *Cheetal* (Journal of Wild Life Preservation Society of India) he lists the Rusty Spotted Cat as one of the nearly exterminated species of animals. Mr. Gee and myself would both feel grateful for any further news which the Society or the readers of the *Journal* may be able to give us regarding this very rare species of cat.

DIGVIR NIVAS,
BANSDA, SURAT DISTRICT,
GUJARAT,
November 22, 1963.

M. S. DIGVEERENDRASINHJI
Maharaja of Bansda

[In Volume **45** of the *Journal* Mr. Humayun Abdulali reported this cat to be fairly common round Suriamal in north Thana District. There is no reason to think that the position has changed.—EDS.]

2. A FURTHER RECORD OF BLAINVILLE'S BEAKED-WHALE, *MESOPLODON DENSIROSTRIS* (BLAINVILLE), FROM THE INDIAN OCEAN : CETACEA

(*With a map*)

In Volume **60** (3) : 727-30 of the *Journal* I recorded the occurrence of Blainville's Beaked-Whale [*M. densirostris* (Blainville)] from the Indian Ocean. Since its publication, Dr. Yaichiro Okada informed

me of a second capture of a male by Japanese fishermen in the Indian Ocean.

In his letter of December 20, 1963, Dr. Okada enclosed some photographs of parts of the specimen which unmistakably indicate the true identity of the species.

The specimen was caught by the fishing boat *Hiyoshima* of Omaizaki at a point 105° 35′ E. × 24° 40′ S., on the 28th October 1963. Unfortunately, only a tooth and a portion of the rostrum was saved from the carcass—the balance of the animal was cast into the sea.

The accompanying map shows the known distribution of the species. The only known females, apparently young animals, are recorded from the North American Atlantic coast. Most of the other specimens recorded (or deduced from the character of the teeth) are males. The breeding area of this species is not established. That males of the various species, especially young males and very occasionally females, wander far from the breeding grounds is illustrated by several species. However, we have yet a lot to learn of the habits and distribution of these comparatively rare whales. Nevertheless, from the records of other species with foetuses, neonatals or young calves, few though they may be, it appears that *Mesoplodon* breeds in the vicinity of the larger archipelagos of the world, during the spring and summer of the Northern and Southern Hemispheres respectively. Although it is perhaps presumptive, it is not unreasonable to suggest that *M. densirostris* breeds (or calves) in the vicinity of the great archipelagos of the Caribbean Sea, i.e. nearest the area where the greatest number of both sexes appear, and that non-breeding males wander in small schools or as lone animals far from their 'home waters'.

The great distances travelled away from 'home waters' may at first sight appear prodigious and naturally arouse some doubts—the distances varying from several hundreds to a few thousands of miles during the interval between one breeding season and the next. However, such distances appear to be of little consequence to such animals as whales. Several of the commercial whales are now definitely known to travel several thousands of miles annually, from feeding to breeding grounds and back again to the feeding grounds, along with the calves within a short space of a few months. The annual migration of the Humpback Whale (*Megaptera nodosa*) is a well-known case, feeding in the Antarctic and breeding in tropical waters near the equator and thence back again to the Antarctic to feed. Little or no feeding takes place during the period the animals

Distribution of Blainville's Beaked-Whale *Mesoplodon densirostris* (Blainv.)

are absent from the main feeding grounds, for sufficient reserve in the shape of blubber is stored during the main feeding season to tide them over the period when the animals are away on their northern sojourn.

17, Clarke Street,
Khandallah,
Wellington, N. 5,
New Zealand,
January 28, 1964.

CHARLES McCANN

3. COMMUNAL BREEDING IN THE WHITEHEADED BABBLER [*TURDOIDES AFFINIS* (JERDON)] IN TAMBARAM, MADRAS STATE

Some common Indian babblers of the genus *Turdoides* Cretzschmar are well known for their communal life.

The interesting fact of their taking a communal interest in breeding activity was observed by Malcolm MacDonald (*J. Bombay nat. Hist. Soc.* **56** : 132-133 and BIRDS IN MY INDIAN GARDEN, pp. 170-171), who recorded noting more than a pair of Jungle Babblers [*Turdoides striatus* (Dumont)] in Delhi showing interest in constructing a single nest, defending the eggs and nestlings when approached, and feeding the young ones in the nest as well as after they left the nest. He noted a similar communal nest-construction in the Large Grey Babbler [*Turdoides malcolmi* (Sykes)] also. Earlier Bates (*J. Bombay nat. Hist. Soc.* **40** : 125 and **56** : 130-131) noted communal nest-feeding in the Jungle Babbler [*Turdoides striatus* (Dumont)] at Agra and Madras. Dharmakumarsinhji (*J. Bombay nat. Hist. Soc.* **58** : 512) recorded communal defence of the fledglings of the Large Grey Babbler [*Turdoides malcolmi* (Sykes)], and Lowther (A BIRD PHOTOGRAPHER IN INDIA, p. 26) observed six different Jungle Babblers [*Turdoides striatus* (Dumont)] feeding three young ones in a nest.

The Whiteheaded Babbler [*Turdoides affinis* (Jerdon)] is distributed throughout peninsular India and Ceylon. Details of its breeding biology are poorly known. It is very common in the scrub jungles around Madras, and is a common resident bird of the Madras Christian College Estate. Recently, a flock of seven in our garden started nesting right under our upstairs window, a splendid opportunity for my wife and me to observe the details of their breeding for about a month.

Construction of the Nest. A five-forked point of a branch at a height of 2.10 m. in a very bushy 3 m. high croton was chosen. Nesting commenced on 30th August. Three or four birds actively participated and all the nest material was collected from within about 9 m. of the nesting site. The three active participants divided the labour among themselves and each faithfully performed its part. One collected dried neem twigs from the ground, another collected the exposed live rootlets of the garden plant *Ervatamia coronaria* Stapf (Tamil : *Nandiyāvattam*), and the third collected green shoots of the weed *Hemidesmus indicus* R. Br. (Tamil : *Nannāri*). The two latter struggled hard, pulling out of the ground and breaking off long pieces from live plants. They worked all day at times unmindful of close passers-by, and completed the nest in three days. Meanwhile, the rest of the flock were engaged in their routine activities near by.

The completed nest was a wide-mouthed, or rather an open, bowl with a diameter of 8 cm. at the rim and about 5 cm. deep at the centre. It was rather coarse, with thicker twigs and rootlets loosely interwoven on the exterior and thin neem twigs closely lining it internally. Just a few green weeds were used; the nest had no fine lining other than the neem twigs. Some adjacent croton leaves were found stuck into the sides of the nest, thereby providing a good camouflage.

Incubation. About a day or two after the completion of the nest, on the 3rd or 4th September, four eggs of the usual unmarked turquoise blue colour were seen in it. Incubation commenced straightaway, and a sitting bird was noted always on the eggs. Only once we noted the sitting bird changing turns with another. The sitting bird was usually reluctant to get off the nest until we got very close to it, and eventually got up with loud protests inviting in a moment the rest of the flock, all of which would hover over us or perch at different spots and chatter loudly with tails spread out and wings half open and quivering. This communal nest-defence was noted not only during incubation but also when the young were in the nest. Several times, we noted the flock chasing and pecking violently at a Jungle Crow or a Koel that chanced to pass close to the nest, and once even a mongoose on the ground was chased away.

Hatching. The first chick hatched out on the 18th, the second on the 19th, and the third on the 21st. Of the three, the earliest was decidedly the largest and it grew faster, developing feather-follicles on the third day and long quills on the back and sides of the body and

on the wings by the fifth day. The fourth egg did not hatch. It was noted on the 23rd September that one of the smaller chicks and the unhatched egg were thrown out of the nest. The culprit is obvious from the fact that the large chick ultimately turned out to be a Pied Crested Cuckoo (see Bates, *J. Bombay nat. Hist. Soc.* **40** : 125).

While the chicks were in the nest, the parent bird did not sit on them but stood with its legs wide apart perched on the nest-rim. At roosting only one of the birds stayed at the nest.

Feeding at the Nest. Feeding commenced after the third chick hatched out. Most members of the flock, including even the sitting bird, joined in the search for food. Sometimes, when three or four found food, all would fly to the nest with characteristic calls, alight near it, and one by one go on to the nest and feed the chicks. Meanwhile, the others would also fly to the nest—they seemed to act as a guard and would warn the feeders against intruders. Feeding was usually done in the cool hours of the morning and the evening, and not during the sunny part of the day. The food consisted of insects, spiders, whip-scorpions, and the like. Once I saw a week-old Garden Lizard (*Calotes versicolor*) being brought by an adult but, as I watched eagerly to see what followed, the adult probably being impatient of my continued presence swallowed the food itself. I noted this habit often, that when the food could not reach the chicks soon the finders themselves swallowed the food that they had brought.

Care of the fledglings. On 30th September the Pied Crested Cuckoo started getting out of the nest and wandering near by in the croton bush. The young babbler was not so venturesome but kept to the nest. On 1st October, the whole babbler flock followed their young fledgling into the garden, leaving the Pied Crested Cuckoo alone in the croton bush. They no longer fed the Pied Crested Cuckoo, but attended their own babbler fledgling, and did not return to the nest. After one day of loneliness, the young Cuckoo disappeared.

DEPARTMENT OF ZOOLOGY,
MADRAS CHRISTIAN COLLEGE,
TAMBARAM, SOUTH INDIA,
January 12, 1964.

P. J. SANJEEVA RAJ

4. DO PSITTACIDS OTHER THAN LORIKEETS SLEEP UPSIDE DOWN?

While the Lorikeet [*Loriculus vernalis* (Sparrman)] is known to sleep upside down, hanging by its feet, I was not aware of this trait in other forms. Some years ago, I walked round the Delhi Zoo rather late in the evening, and was surprised to see Blossomheaded Parakeets [*Psittacula cyanocephala* (Linn.)] roosting against the wire netting of their cage, with their heads down, and apparently asleep.

Subsequently Mr. Reuben David, Superintendent of the Municipal Hill Garden Zoo, Ahmedabad, informed me that he had observed this habit in most parrots, cockatoos, lories, budgerigars.

This fact does not appear to be generally known, and it would be interesting to learn to what extent this habit is natural or brought about by captive conditions.

MESSRS FAIZ & CO.,
75, ABDUL REHMAN STREET, HUMAYUN ABDULALI
BOMBAY 3,
January 16, 1964.

5. OCCURRENCE OF *SYLVIA MINULA MARGELANICA* STOLZMANN AT KUTCH, GUJARAT STATE

During the BNHS/WHO bird migration study project at Kuar Bet, Kutch, in March 1960, a Whitethroat (*Sylvia*) caught in the nets appeared to be the Small Whitethroat (*S. minula*) and its skin was preserved for comparison. Dr. Vaurie who later examined the specimen and three other skins from the Society's collection identified as *S. curruca* reports that three of them including the specimen collected at Kuar Bet are *S. minula minula*, and that B.N.H.S. No. 5864 (*Measurements:* Wing 68; Bill 9; Tail; Tarsus 21 mm.) is perhaps *S. m. margelanica* Stolzmann. I would draw the attention of ornithologists in the Kutch area to the possibility of the occurrence of this race in Kutch.

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD, P. W. SOMAN
BOMBAY 6-WB., *Research Assistant*
February 12, 1964.

6. A BIRD STUDY TRIP TO THE LACCADIVE ISLANDS

The sandbank of Pitti and the atoll Baliapanni or Cherbaniani, in the Laccadive group of islands, have been known from the early nineteenth century to harbour many varieties of terns. The Administrator, Shri Murkot Ramunny, who is keenly interested in the bird life of the Islands, agreed to the Society's suggestion to explore the potentialities of the Laccadives as a centre for studying the breeding habits and migratory movements of terns in the Arabian Sea, and offered to take two members of the Society's research staff to the Islands.

We left Bombay on 12 October 1963, and on the 16th boarded at Calicut the cargo ship *Dhanalakshmi* chartered by the Administrator. Between the 17th and 22nd we visited six islands, viz. Kavrathi, Pitti, Agathy, Chetlat, Bitra, and Baliapanni in that order. None of them showed a distinctive fauna. White-eyes and koels were the only resident birds we saw, and crows are reported to occur on Amini Island. A species of skink was the only reptile seen by us though Shri Ramunny saw some snakes on an islet of the Baliapanni atoll.

Presented below in chronological order are brief accounts about the islands we visited:

17th October, Kavrathi, 10° 35′ *N.*, 72° 35′ *E.* This is a little island some 865 acres in area with a fair-sized lagoon. It has scanty bird life. The islanders pointed to Pitti as the place where birds are seen in abundance.

18th October, Pitti, 10° 30′ *N.*, 72° 30′ *E.* 'The extreme southernmost point of an enormous sunken sandbank about 200×300 yards in area, and standing some 6 or 7 feet above high watermark' is how Hume (1876) describes Pitti. We reached this island, which lies some 15 miles north-west of Kavrathi, by motor launch. As the island is surrounded by shallow water, we reached the beach in a countrycraft, piloted safely through the heavy surf and coral reefs by the experienced islanders hired by Shri Ramunny. The islanders held contradictory opinions on the bird population of this uninhabited sandbank, some holding that birds are seen here throughout the year and others that they leave by the end of October. It is certain that thousands of Philippine Noddies and Large Crested Terns nest here between April and September every year. By July the bird population reaches a peak and egg collectors have their field-day! The present Administrator has banned all such collection trips. At the time we visited the island breeding activity at Pitti was

nearly over. We caught and ringed 16 and 18 young respectively of the Large Crested Tern (*Sterna bergii*) and the Philippine Noddy (*Anoüs stolidus*). As the young had not attained flight we could catch them after a good chase. A solitary nestling of the Noddy (about 2 weeks old) was also taken. A mist net we erected was totally ineffective in the high wind. We saw several flocks of Turnstones at Pitti. The islanders remarked that their nooses would have been effective in trapping such shore birds.

18-19*th October, Agathy,* 10° 50′ *N.,* 72° 10′ *E.* Another fertile island, some 688 acres in area. Agathy is in the middle of an elliptical reef. It is thickly planted with coconut interspersed with breadfruit trees and is poor in bird life. White-eyes (*Zosterops palpebrosa*) and the Koel (*Eudynamys scolopacea*) were the only resident birds we saw. As we saw no crows we presume that koels are visitors from Amini or perhaps the mainland. An islander showed us a turtle dove (*Streptopelia orientalis*) which he had trapped for the pot. The species was reported to be a regular visitor after the monsoon.

19-20*th October, Chetlat,* 11° 44′ *N.,* 72° 40′ *E.* A little island of some 255 acres, Chetlat has a beautiful sandy beach frequented by turnstones, Little Stints, and Kentish Plovers. As night sets in the lagoon is lit by millions of phosphorescent sea animals which almost form a luminous girdle around the island.

20*th October, Bitra,* 11° 35′ *N.,* 72° 10′ *E.* The smallest (26 acres) inhabited island we visited, Bitra showed the largest number of shore birds. We noted nine varieties including a Pipit (*Anthus* sp.) and 6 to 8 Greyheaded Yellow Wagtails (*Motacilla flava thunbergi*). Bitra is part of a regular atoll, and has a shallow lagoon at its northern end.

20-21*st October, Baliapanni or Cherbaniani,* 12° 20′ *N.,* 71° 50′ *E.* Hume describes Baliapanni as 'a long oval atoll some $6 \times 2\frac{1}{4}$ miles in its extreme dimensions'. We could visit only one islet in the atoll. The ship anchoring some 400 yards away from the atoll lowered a canoe and paddling along the north-west aspect of the atoll we landed on the islet without difficulty and began ringing. From a distance we had seen a gathering of Sooty and Brownwinged Terns, but the islet we visited appeared to be used almost exclusively by Brownwinged Terns. During our 2-hour stay, we ringed 5 young Brownwinged Terns and 18 nestlings. Our identification is based partly on the identity of the parent birds which would swoop down within a few feet as we handled the chicks. However, the eggs we

collected apparently belonged to another species[1]. We saw about a dozen rotten eggs and as many mummies of nestlings.

We could not explore any other islet in the group for lack of time, but suspect Sooty Terns to be breeding on another islet. As the party had to return to Calicut on the 23rd, Baliapanni was the last island we visited.

Pitti and Baliapanni as bird-ringing stations. From the information received from the islanders one fact emerges, viz. that between April and October Pitti and Baliapanni are used for breeding by large numbers of terns. Such enormous concentrations offer an excellent opportunity for studying the breeding biology of these terns. From the point of view of ringing April appears to be the best month. With assistance from the Administration, a batch of ringers can reach Kavrathi or Chetlat by cargo ship and using these islands as a base they can reach Pitti or Baliapanni by chartered motor launches (at about Rs. 30 per day) towing the country crafts needed for landing. About 6 islanders can take a party ashore safely. The main difficulty is that these sandbanks have no fresh water or shelter from weather, and unless adequate arrangements can be made the party will have to return to the base camp after finishing each day's work. Of the two islands Pitti is more easily, even though less safely, accessible, but Baliapanni has a greater variety of birds. The terns can be caught by hand, and islanders can be employed to trap turnstones with nooses.

These uninhabited islands can be turned into useful bird ringing stations but the cost per bird will be higher than on the mainland.

List of birds seen. The following species of birds were observed by us between October 16 and 22, either on or about the islands:

Oceanites oceanicus (Kuhl). Wilson's Storm Petrel.

On passage between Calicut and Kavrathi this species was seen several times. Two or three of these birds followed the wake of the ship for a long time attracted by a baited line.

Oceanodroma leucorhoa monorhis (Swinh.). Ashy Storm Petrel.

Mr. Madhavan caught this bird as it came on the ship between Chetlat and Bitra on October 20. The bird was uniform sooty black

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[1] The eggs have been identified as eggs of the Large Crested Tern, *Sterna bergii*, by Mr. C. J. O. Harrison, British Museum (Natural History), London. The chicks have been identified in the Society's office as the Brownwinged Tern, *Sterna anaethetus anaethetus*.—Eds.

throughout and had a slightly forked tail. Its measurements were: Wing 150 mm., Bill 13 mm., Tail 64 mm., Tarsus 22 mm., and weight 38 grammes. As the bird was in perfect health we released it with a band.

Ardeola grayii (Sykes). Pond Heron.

Solitary bird seen about 15 miles off Bitra.

Egretta sp. [? **gularis** (Bosc.)]. Reef Heron.

Solitary bird seen at Kavrathi on coral reef.

Pluvialis squatarola (Linnaeus). Grey Plover.

Single bird seen on beach at Chetlat.

Pluvialis dominica (P.L.S. Müller). Golden Plover.

Seen at Chetlat and Bitra on the beach.

Charadrius alexandrinus Linnaeus. Kentish Plover.

Seen singly and in flocks of 8 to 10 at Chetlat and Bitra on beach and coral reefs.

Numenius phaeopus (Linnaeus). Whimbrel.

Solitary bird seen on our way from Calicut about 10 miles off Kavrathi.

Numenius arquata (Linnaeus). Curlew.

A flock of three birds seen on the beach at Bitra.

Tringa hypoleucos Linnaeus. Common Sandpiper.

Seen on all the four inhabited islands we visited.

Arenaria interpres (Linnaeus). Turnstone.

The commonest wader we saw. This species was seen in flocks of 8 to 20 at Pitti, Chetlat, Bitra, and Baliapanni.

Calidris minutus (Leisler). Little Stint.

Seen on coral reef at Agathy, Chetlat, and Bitra.

Dromas ardeola Paykull. Crab Plover.

A pair was seen at Bitra by V.C.A.

Catharacta sp.

A large Brown Skua (Antarctic Skua ?) was seen at Baliapanni atoll, hovering over a gathering of terns and on our way between Calicut and Kavrathi.

Sterna anaethetus Scopoli. Brownwinged Tern.

A few hundred seen at Baliapanni where we ringed chicks of this species.

Sterna fuscata Linnaeus. Sooty Tern.

Gatherings of this species and Brownwinged Terns seen at Baliapanni.

Sterna bergii velox. Cretzschmar Large Crested Tern.

A few hundred birds seen at Pitti sandbank along with Noddy Terns.

Anoüs stolidus pileatus (Scopoli). Noddy Tern.

This species was breeding at Pitti. A nestling about two weeks old taken from a crevice in the coral reef at Pitti is being reared by Shri Madhavan. We ringed 18 birds of this species at Pitti.

Streptopelia orientalis (Latham). Rufous Turtle Dove.

At Chetlat an islander showed us a bird he had trapped for food. According to local information this species is a frequent visitor to this island after the monsoon.

Eudynamys scolopacea (Linnaeus). Koel.

A pair was seen on a Banyan tree near the Dak Bungalow at Agathy.

Alcedo atthis (Linnaeus). Common Kingfisher.

Single bird seen at Kavrathi.

Hirundo rustica Linnaeus. Swallow.

A few birds were seen a mile off shore at Kavrathi.

Delichon urbica (Linnaeus). House Martin.

A solitary bird came on our ship between Calicut and Kavrathi. A flock of some 10 birds was seen at Chetlat.

Anthus sp.

A solitary pipit seen on coral reef at Bitra.

Motacilla flava thunbergi Billberg. Greyheaded Yellow Wagtail.

A flock of some six birds seen on the beach at Bitra. One could get quite close to these birds.

Zosterops palpebrosa (Temminck). White-eye.

Seen at Kavrathi, Agathy, and Chetlat. Very common on the first two islands roosting on shrubs (introduced) 4 to 5 feet from the ground.

ACKNOWLEDGEMENTS

We are grateful to the Administrator of the Laccadives, Shri Murkot Ramunny, and to Shri E. K. Madhavan, Special Officer for Fisheries, for help extended to us and for the permission to refer to notes kept by the latter.

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD,
BOMBAY 6-WB.,
April 3, 1964.

D. N. MATHEW
V. C. AMBEDKAR
Research Assistants

REFERENCE

HUME, ALLAN OCTAVIAN (1876): The Laccadive and the West Coast. *Stray Feathers* **4**: 413-482.

7. OBSERVATIONS ON THE EGG-LAYING OF THE FANTHROATED LIZARD, *SITANA PONTICERIANA* CUV.

(*With two plates*)

On 20 August 1963 three Fanthroated Lizards, *Sitana ponticeriana* Cuv., were collected from Vetal Hill, about 3 km. west of Poona. They were kept under observation in a cage made of a wooden box covered with netting and lined with a layer of soil and two or three stones. They were fed with spiderlings, cockroaches, and other small insects. Two of the lizards were adult males and the third a gravid female. One of the males was continually fanning its gular appendage, an act of courtship peculiar to this species.

On the 29th morning at about 10 hours 30 min. the female started digging a hole with its forelimbs, shovelling the earth backward with its hindlimbs. By 11 hours 10 min. the hole was about 3 in. deep (Plate I, 2). Then straddling the hole she laid her first egg at 11 hours

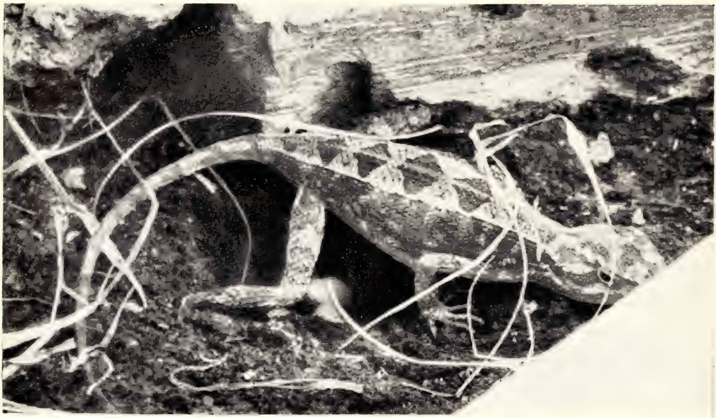
Sitana ponticeriana Cuv.

1. Female basking on a twig

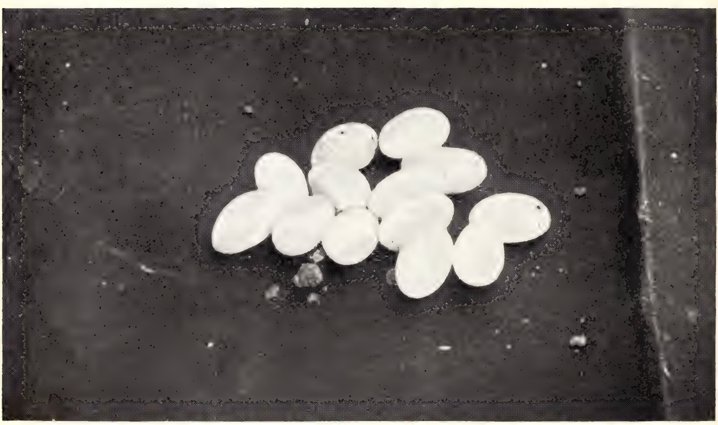
2. Female digging pit with forelimbs

Photos : R. N. Chopra

Sitana ponticeriana Cuv.



1. Female laying eggs



2. Eggs of second clutch (in petri dish)

Photos : R. N. Chopra

15 min. (Plate II, 1). The clutch of 11 eggs was completed by 11 hours 28 min. 30 sec. The eggs were laid in one heap, one on top of another. Then she arranged them side by side in the pit so that they did not overlap each other, replaced the soil with her forelimbs, and patted it down with her hindlimbs and snout.

On the 31st the female was covered by a male. The details of the courtship and the method of pairing will be dealt with in a separate communication. On the 10th September the female was noticed to be gravid. On the 17th morning she prepared another pit as before and between 10 hours 54 min. and 11 hours 5 min. laid a clutch of 13 eggs.

During the 3rd and 4th weeks of September the male was seen chasing the female but copulation was not observed. As she showed signs of being gravid in the 1st week of October copulation must have taken place. In the morning of the 10th October between 11 hours 16 min. 30 sec. and 11 hours 26 min. 38 sec. she laid a clutch of 14 eggs.

Thus, within a period of 41 days the female laid 38 eggs.

The eggs are small, ellipsoid in shape, with a soft chalky white shell (Plate II, 2). They are free, not stuck together as is often the case with reptile eggs. The average dimensions as measured from the last clutch was 10 mm. × 6 mm. According to Smith (FAUNA OF BRITISH INDIA, REPTILES **2** : 146) the clutch size is 6 to 8 eggs.

ZOOLOGICAL SURVEY OF INDIA,
WESTERN REGIONAL STATION, R. N. CHOPRA
POONA 5,
November 30, 1963.

8. A FIRST RECORD OF BREEDING COLOUR CHANGES IN A TORTOISE

Colour changes associated with the breeding season have never been reported in turtles. Thus a note on the presence of such changes in *Geochelone travancorica* (Boulenger) is worthy of publication.

The colour changes accompanying the breeding season in this species (November through January) are found in both males and females, though decidedly more noticeable in the former. These changes involve the eyelids and particularly the skin covering the remainder of the orbital depression, as well as the nasal area—particularly that below the narial openings.

In adult specimens of *Geochelone travancorica* these areas frequently possess a pinkish colour which is intensified during the breeding season. In breeding males these colours change to a fairly bright red, contrasting strongly with the remaining light yellow-brown of the remainder of the head.

Head movements during courtship in this species are believed to be unimportant in species identification. The change in colour is thus presumed to be caused by increased vascularization in the area of organs known to be important in sex and/or species recognition, i.e. the olfactory and visual organs. This vascularization may occur in other species of tortoises as well, but is so evident in *G. travancorica* because of the generally lightly-pigmented head.

FLORIDA STATE MUSEUM,
UNIVERSITY OF FLORIDA,
GAINESVILLE, FLORIDA,
February 29, 1964.

WALTER AUFFENBERG

9. DESCRIPTION OF A NEW SPECIES OF TOAD (ANURA : BUFONIDAE) FROM SATARA DISTRICT, MAHARASHTRA, INDIA[1]

(*With two plates*)

In early 1962 arrangements were made, with the co-operation of the Chief Engineer, Koyna Dam Project, Koyna, Satara District, Maharashtra, for the Society's personnel to visit the project area and collect reptiles and amphibians that might be flooded out when the water level rose during the monsoon. On information being received in July that the water level of the dam was rising, two assistants of the Society, P. W. Soman and P. B. Shekar, were sent to the dam area and while collecting on the crest of a hill, covered with vegetation and occasional pools, near Humbelevi village saw several small toads, some in amplexus. They had not in their experience seen breeding toads of such small size and a series was collected. On a subsequent visit on 1st September the toads were found in similar numbers among the grass and under stones in the same area; a large number of juveniles were also noted.

Examination of a series of these toads shows that they are distinct from the species of *Bufo* hitherto described.

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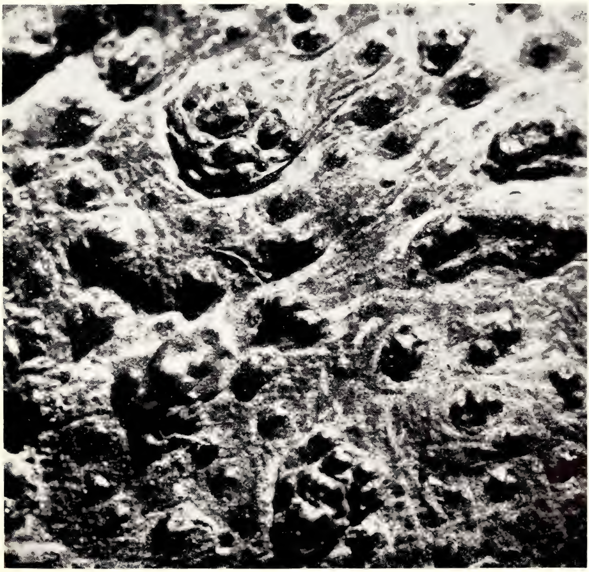
[1] Manuscript posted from London 28th November 1963; received in the Society's Office 2nd December 1963.—EDS.

Bufo sulphureus sp. nov.

1. Dorsal view of head of holotype × 5



2. Section of dorsolateral skin immediately behind parotoids ×14

Bufo sulphureus sp. nov.

Ventral view of holotype × 4

Bufo sulphureus sp. nov.

Material examined. Holotype an adult ♀, Reg. No. 377 in the collections of the Bombay Natural History Society, collected at approximately 4000 ft. near Humbelevi village, Koyna, Satara District, Maharashtra. Paratypes: 5 ♂♂, 11 ♀♀, 10 juveniles from the same locality. These specimens will be deposited in the collections of the British Museum (Natural History), the Indian Museum, and the Bombay Natural History Society.

Diagnosis. A small-sized species of *Bufo* (mature individuals less than 34 mm. in body length) without cephalic ridges; tympanum inconspicuous, in diameter less than one-quarter that of the eye; parotoids subtriangular, indistinct; fingers without web; toes long and slender with a rudiment of web; subarticular tubercles single, not prominent; no tarsal ridge. Body covered with small, round, melanin-tipped warts which are irregularly scattered on an otherwise smooth dorsum. In life dark brown with yellow patches on the flanks, thighs, and shoulders.

Description of Holotype. Size small (29.4 mm. snout to vent), cranial crests absent; snout short, only slightly rounded in profile, deeply concave above; canthus rostralis marked off by a prominent, almost straight ridge formed of a single row of rounded tubercles which continues round the anterior border of the eye; loreal region strongly sloping, lips flaring out below; nostrils lateral and swollen, twice as near to the tip of the snout as to the eyes; interorbital width subequal to the upper eyelid, which has a thickened rim bearing tubercles. Tympanic annulus not very distinct, in diameter about one-fifth that of the eye; the tympanic area strongly tuberculate, the tubercles masking the tympanum. Parotoid glands inconspicuous, subtriangular, the posterior ends decidedly narrower than the anterior ones. Fingers free, not dilated, first finger slightly longer than second; subarticular tubercles single but feebly developed. Toes not fringed and with only a rudiment of web at basal phalanges; subarticular tubercles single, barely visible; two metatarsal tubercles, the inner one larger and more prominent; no tarsal ridge. Tarso-metatarsal articulation reaches to the tympanum. Dorsal skin set with low, rounded, melanin-tipped, irregularly scattered tubercles of unequal size which are well separated by areas of smooth skin. Lips smooth. Tubercles on limbs closer set, more conical and showing a tendency towards spinosity. Ventral surfaces granular.

Colour. Dorsal surfaces uniform dark brown, exceptionally with slight suffusion of dull chrome-yellow. Bright chrome-yellow patches

on the flanks, sides of thighs, and above the arm insertions. Lips and ventral surfaces cream; occasionally small, irregularly shaped, dark brown spots and blotches on the throat and abdomen. Tubercles on the under surface of limbs, around the vent, and on the infra-tympanic area whitish in some specimens.

Secondary Sex Characters. The males vary in the degree to which their sex characters have developed. All bear nuptial asperities consisting of clusters of dark brown spinules but only in the most sexually advanced example do they cover the latero-dorsal surface of the first and second fingers as well as the inner lateral aspect of the third finger. Similar spinules are present on the inner palmar tubercle. A median subgular vocal sac which communicates with the mouth by means of a wide slit (on the right side in four examples, on the left side in one) is also present. In three of the specimens the posterior half of the sac has a broad, heavily pigmented, transverse band.

Variation. The webbing in the holotype is more reduced than in some other, better preserved specimens in the type series, which have $2\frac{1}{2}$ phalanges free from web on the external side of the 3rd toe and $3\frac{1}{2}$-$3\frac{3}{4}$ free on both sides of the 4th toe.

Remarks. This species most closely resembles *Bufo brevirostris* Rao (type locality Hassan District, Mysore State) but can be distinguished by its smaller tympanum, concave head, and differing integument. The upper surface of the skin of *brevirostris* is said to be covered with small, uniformly distributed tubercles, with a small row of larger warts on the median line of the back, and the throat and abdomen are described as having spiny tubercles. In *sulphureus* the dorsal tubercles are irregularly scattered and there is no spinosity of the venter.

British Museum (Natural History),
Cromwell Road, ALICE G. C. GRANDISON
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91, Walkeshwar Road, J. C. DANIEL,
Bombay 6-WB., *Curator*
December 2, 1963.

Reference

Rao, C. R. N. (1937): On some new forms of batrachia from S. India. *Proc. Indian Acad. Sci.* 6B (6): 387-427.

10. DEATH BY COLD OF FISH IN THE RIVER GANDAK, INDIA

Though several natural and artificial causes of fish mortality in rivers are known (Klein 1957), instances of fish getting suddenly numbed in a section of a fluviatile habitat, apparently caused by sudden lowering of water temperature, appear to be unknown in India. The phenomenon of 'cold shock' is, however, well known throughout Europe and N. America. Rounsefell & Everhart (1953) speak of some 'warm water fish' in ponds becoming powerless to move and of coastal fish dying during sudden cold spells. While engaged in fisheries survey in the vicinity of the proposed Gandak barrage near Bhaisalotan, north Bihar, the authors observed a case of large-scale numbing and surfacing of fish at the barrage site on 5-3-1962, occasioned by sudden intense hailstorms. The phenomenon observed, with its probable cause, is presented in this note.

The River Gandak, originating in the high Himalayan ranges of central Nepal, passes through precipitous gorges before emerging into the plains, a short distance above the proposed barrage site at Bhaisalotan, which lies on the left bank of the river in the Indian territory. The incidence of distress among fish was observed in about 1.5-2.0 m. deep, two mile long stretch of the smaller left fork of River Gandak which joins its main right diversion a little further downstream. Sonapancha, a small tributary, joins the Gandak on the left bank just above the bifurcation mentioned above, bringing in considerable torrential flow after every precipitation, which mostly drains off along the left channel at the foot of Bhaisalotan.

Prior to the precipitation accompanied by two hailstorms on 5-3-1962, the rubble-studded, sandy river-bed, close to Bhaisalotan, had very clear, gently flowing water and an abundant growth of filamentous algae (*Spirogyra* sp.) with many boulder-lined shelter pools, and considerable congregation of fish was noticed at that site in the river in general and in the shelter pools in particular.

Hailstorms accompanied by heavy rain visited the site twice on 5-3-1962, first at 10 a.m. and next at 11 a.m., the former lasting half-an-hour and the latter, the more intense one, for about 45 minutes, carpeting the ground at places with about 10 cm. deep hailstones. The temperature of the left fork of the Gandak was 18.20° C. prior to the first downpour, which lowered the temperature to 17° C. The second spell of rain and hail, however, suddenly lowered the temperature of the Sonapancha to 5° C., the cold waters of the tributary in turn reducing the temperature of the left branch of Gandak to 6.5-7° C.

within a short time. Soon after the water got suddenly chilled, hundreds of fish surfaced appearing stunned and dazed and showing signs of deep distress, though none appeared to be dead. Well over a hundred villagers and labourers, shortly thereafter, gathered on both the banks of the channel to take a rather effortless catch of fish with impromptu fish-catching devices like hand and scoop nets and sheets of cloth of various dimensions. Many held sticks and bamboo poles in their hands to beat and capture some semi-stunned fish. Later, some small fishing nets were brought and the hauls were made somewhat more systematically. This fishing activity continued for about an hour and about 1000 kilograms of fish were collected. The species composition of the affected fish, stated in the order of decreasing frequency of occurrence is given in Table I:

TABLE I

SPECIES OF FISH AFFECTED BY THE CHILLING OF WATER

Major species	Minor species
1. *Wallago attu* (Bl. & Schn.)	1. *Oxygaster gora* (Ham.)
2. *Mystus* (*Osteobagrus*) *seenghala* (Sykes)	2. *Aspidoparia morar* (Ham.)
3. *Mystus* (*Osteobagrus*) *aor* (Ham.)	3. *Osteobrama cotio cotio* (Ham.)
4. *Labeo gonius* (Ham.)	4. *Mystus* (*Mystus*) *cavasius* (Ham.)
5. *Ompok bimaculatus* (Bloch)	5. *Mystus* (*Mystus*) *vittatus* (Ham.)
6. *Cirrhina mrigala* (Ham.)	6. *Puntius sophore* (Ham.)
7. *Puntius sarana* (Ham.)	7. *Puntius ticto ticto* (Ham.)
8. *Labeo rohita* (Ham.)	8. *Glossogobius giuris* (Ham.)
9. *Labeo bata* (Ham.)	9. *Crossocheilus latius latius* (Ham.)
10. *Channa striatus* (Bloch)	10. *Barilius barila* (Ham.)
11. *Channa marulius* (Ham.)	11. *Rasbora daniconius* (Ham.)

Water samples from four different spots in the affected zone were promptly collected to draw a picture of the physico-chemical conditions of the river at the time when the fish were displaying distress, for comparison with those obtaining in the stream normally. Table II presents the salient physico-chemical characters of the river as on March 2-3 and on March 5, 1962, the latter during the actual period of fish distress.

From the foregoing account it is seen that a sudden sharp fall of 11.7° C. in the water temperature occurred in the affected zone of River Gandak prior to fish displaying distress. The pH value registered a fall from 8.3 to 7.5 with carbon dioxide concentration rising from *nil* to 30 p.p.m. Turbidity rose from *nil* to 2500 p.p.m. and the specific conductivity decreased from 290 to 93 mho. Ammonia appeared in traces (0.05 p.p.m.) where there was none before.

TABLE II

PHYSICO-CHEMICAL CONDITIONS OF THE LEFT GANDAK CHANNEL*

	Diurnal variations before the hailstorm on 2-3rd March 1962								During actual period of distress on 5-3-62
	7 a.m.	10 a.m.	1 p.m.	4 p.m.	7 p.m.	10 p.m.	1 a.m.	4 a.m.	
1. Water temp. (in °C.) ..	18.1	19.5	22.3	22.9	21.0	20.1	19.0	18.2	6.5–7.0
2. Turbidity ..	Clear Water								2,500
3. pH ..	8.3	8.4	8.5	8.6	8.5	8.5	8.4	8.3	7.5
4. Dissolved oxygen (D.O.)	7.4	8.2	9.6	9.6	8.3	7.7	7.6	7.4	8.7
5. Free CO_2 ..	0	0	0	0	0	0	0	0	30
6. Hardness ..	—	144	—	—	—	—	—	—	80
7. Specific conductivity ($\times 10^{-6}$ at 25°C.): in mho.	—	290	—	—	—	—	—	—	93
8. Alkalinity ..	—	116	—	—	—	—	—	—	48
9. Chloride ..	—	7.5	—	—	—	—	—	—	40
10. Oxygen consumption ..	—	8.0	—	—	—	—	—	—	25
11. Free ammonia ..	0	0	0	0	0	0	0	0	0.05

* Results expressed in parts per million except where stated otherwise

Apart from metallic contaminants, poisonous gases, and other toxic substances which are lethal to fish when released generally with trade and domestic effluents, the natural factors which cause fish distress, and at times mortality, are low dissolved oxygen, high carbon dioxide concentration, presence of ammonia, and extraordinarily high turbidity. The dissolved oxygen value of 8.7 p.p.m. noted at the time of distress was sufficiently high (higher than normal) and, therefore, the question of considering this factor as a cause of distress does not arise, specially when, at the prevalent low temperature, the metabolic processes of fish must necessarily have been physiologically retarded. Carbon dioxide at concentrations up to 30 p.p.m., in the absence of ammonia, does not prove lethal to fish even if there is a 12 hour exposure, as observed by Alabaster & Herbert (1954). Further, any higher carbon dioxide concentration (up to 60 p.p.m.) serves only to reduce the toxicity of ammonia. Alabaster & Herbert (op. cit.) have further observed that lowering of pH value is a vital, if not the only, cause of reduction of toxicity of ammoniacal solutions. In the observation reported here, the pH recorded was 7.5, ammonia 0.05 p.p.m., and carbon dioxide 30 p.p.m. Since fish distress was observed an hour or so after the cessation of rain, the probability of either carbon dioxide or ammonia being responsible for the phenomenon is perhaps negligible. The sudden change in turbidity from clear water to as high as 2500 p.p.m. might have caused a certain degree of impediment to the functioning of the fish gills. Even this may not be tenable as a cause for fish distress since, in such a case, the fish could have easily escaped into comparatively clear water areas further downstream. Besides, it has been observed by one of the authors (A.D.) that in some of the larger rivers of the Ganga river system, turbidity values during monsoon floods normally rise up to 2000 p.p.m. and values even as high as 5000 p.p.m. are recorded in the Ganga, but fish distress at such times is not known to occur. A turbidity of 6000 p.p.m. in Potomac river, recorded by Kemp (1949), did not prove harmful to fish. Higher values, however, may be dangerous after a prolonged exposure (Herbert & Merkens 1961). As pointed out by Kemp (op. cit.) a turbidity of 3000 p.p.m. is considered dangerous to fish when maintained over a 10-day period. In laboratory experiments with trout, Herbert & Merkens (op. cit.) observed that solid concentration, when raised intermittently by hand stirring to 10,000 p.p.m., did not cause any mortality, and the fish finally died only when concentrations were raised to 175,000 p.p.m. and beyond. These lethal turbidities caused death within 2 hours of exposure. Griffin *et al.* (1945) observed that fish withstand turbidities

from 300 to 6500 p.p.m. However, a much higher value of 20,000 p.p.m. caused by wood fibres was recorded by Cole (1955), when healthy fish did not die. In the present case the absolute value of turbidity was well within the tolerance limit but may have contributed to fish distress because of its sudden appearance.

The water temperature, which normally varied between 18.1 and 22.9° C. during a 24 hour period on 2-3rd March 1962, and the early morning temperature of 18.20° C. recorded on the same day came down to as low as 6.5-7° C. within a couple of hours, probably directly affecting the nervous system of the fish and numbing or paralysing their musculature. As a result, the fish became stunned, lost their normal capacity to swim, and floated helplessly in the chilly waters.

All the victims listed in Table I, are warm-water forms which inhabit the middle and lower reaches of north Indian rivers where the water temperature in summer months reaches up to 32° C. Though cold-water forms like *Tor* sp. (Mahseers), *Lissocheilus hexogonolepis* (Katli Mahseer, *Bagarius bagarius* (the 'Goonch'), several species of *Glyptothorax*, several species of *Barilius, Danio* sp., *Garra* sp., *Labeo dyocheilus, L. dero,* and others are known to be present in the river, as revealed by a fish survey (David 1963), not a single specimen showed distress and surfaced at the time when the fish listed were exhibiting distress. This observation lends support to the contention that the main cause of the numbing and distress among fish, reported here, was the sudden lowering of water temperature from 18.2° C. to 6.5° C.

In India little work has been done, so far, to demarcate accurately the geographic distribution of economic species of fish according to the temperature gradients which prevail in streams and rivers of the country. The degree of temperature tolerance and preference of some fish relative to their surrounding media are still to be experimentally elucidated for a proper understanding of the hydrographic factors involved. The subject has at the present juncture assumed great importance especially in the context of the urgent need to develop the high altitude fisheries of the Himalayan region.

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11. DEATH BY COLD OF COMMERCIAL CARPS IN DELHI

Large-scale mortality of commercial carps in the Government-owned nursery tank in Shahadra during the latter part of December 1961 when Delhi experienced a severe cold forms the subject matter of the present communication.

The Shahadra nursery tank is a rectangular pond with an area of about half acre and an average depth of 5 feet during the monsoon. In summer its water level falls rapidly and the tank dries up in June. It has a luxuriant growth of *Potamageton pectinatus* Linnaeus and *Vallisneria spiralis* Linnaeus.

The mortality occurred during the period 18-12-1961 to 26-12-1961 in the early hours between 3-7 a.m. About 5000 fingerlings of the major carps ranging from 40-60 mm. were estimated to have been killed. In addition, a large number of other fishes were noticed in distress. The estimated percentage of dead fishes is given in Table I.

Table I

Species	Local name	Percentage mortality
1. *Catla catla* (Hamilton)	Catla	28%
2. *Labeo rohita* (Hamilton)	Rohu	27%
3. *Labeo bata* (Hamilton)	Bata	5%
4. *Labeo calbasu* (Hamilton)	Kalbons	3%
5. *Cirrhina mrigala* (Hamilton)	Mrigal or Narain	35%
6. *Cirrhina reba* (Hamilton)	Reba	2%

The water chemistry of the tank during the period of mortality showed normal values. The earlier records kept by the Fisheries Department from the same tank revealed that the water was free from any pollutant. Careful examination of the fishes was carried out and revealed no major fungal, parasitic, or bacterial infection. Observations made on the qualitative and quantitative nature of the plankton showed its normal and usual composition.

The meteorological data along with the percentage mortality are presented in Table II. The atmospheric temperature showed wide fluctuations during the period of observation. The maximum temperature recorded on December 17 was 21.5° C., while on December 24 it was 10.5° C. The corresponding water temperatures on these days were 8.0° C. and 1.5° C. respectively. The water temperature closely followed the atmospheric temperature as shown in Table II. The severe winter spell started on December 18 and continued to December 26. The heavy fog, gusty winds, and the winter rains brought the temperature of water down to near freezing point. It may be recalled that this was the period when Delhi experienced the severest cold spell during the last 80 years.

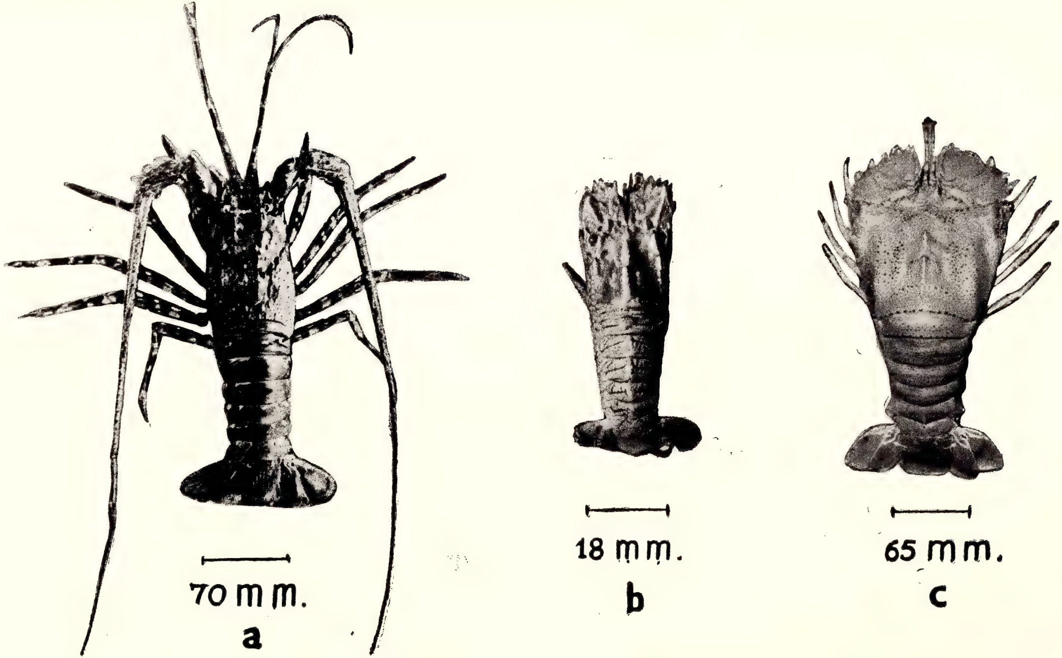
The available evidence suggests that the fish mortality in Shahadra tank was due to severe winter. Death of fishes in natural environments due to cold seems surprising in tropical waters. Delhi Territory is situated in a region which has been variously classified as monsoon and upland Savannah or dry sub-humid. The climate is very periodic with a dry hot summer, a warm monsoon period, and a dry and cold winter from October to February. The water temperature in summer goes as high as 36° C. and down to near freezing point in winter. As these fishes are used to high temperature any drastic fall in temperature seems sufficient to cause gross mortality.

A general survey of other fish tanks in Delhi also showed fishes dying during the cold spell. A perusal of Table I suggests that large-scale mortality was confined to a few species and the record of fingerlings introduced shows that the percentage mortality of major carps closely followed the percentages stocked. The stocking ratio followed in Delhi Territory is 30% Rohu, 30% Catla, and 40% Mrigal.

The fish mortality reported by Verrill (1901) off the coast of Bermuda at 7° C. supports the author's conclusions. The present findings are also in agreement with the view that tropical fishes succumb more easily to cold than fishes in temperate regions (Storey & Gudger 1936; Storey 1937).

TABLE II

Date	Atmospheric Temperature °C.		Water Temperature °C.	Rainfall in past 24 hours	Percentage mortality
December 1961	Maximum	Minimum	Recorded between 10-11 a.m.	mm.	
17	21.5	10.4	8.0	nil	nil
18	12.1	5.7	6.5	0.8	5%
19	12.5	5.2	5.8	8.8	6%
20	12.7	4.5	4.9	nil	7%
21	12.8	3.9	4.2	nil	8%
22	12.4	2.3	2.7	nil	12%
23	12.2	2.1	2.6	nil	16%
24	10.5	1.2	1.5	nil	46%
25	17.1	6.3	7.2	nil	nil
26	18.0	6.8	7.0	nil	nil



(a) *Panulirus ornatus* (b) *Scyllarus sordidus* (c) *Thenus orientalis*

ACKNOWLEDGEMENTS

I am grateful to Dr. (Miss) M. Chandy, Reader in Zoology, University of Delhi, for critically reading my manuscript. Thanks are due to Mr. K. L. Dixit for providing the meteorological data.

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12. FURTHER RECORDS OF LOBSTERS FROM BOMBAY

(*With a plate*)

Three species of spiny lobsters have so far been recorded from Bombay, viz. *Panulirus polyphagus* (Herbst), *Panulirus dasypus* (H. Milne-Edwards), and *Panulirus versicolor* (Latreille). Subsequent collections made by the authors have revealed the occurrence of one more species of spiny lobster and two of squat lobsters (family Scyllaridae).

The fishing season of 1961-62 was noted for the paucity of mackerel off the Ratnagiri coast. This has variously been attributed to temperature fluctuations and veering of the currents. The almost complete disappearance of mackerel from Ratnagiri was accompanied by the presence of marine forms at Bombay which do not normally occur there. Thus two fishes, the Moorish idol *Zanclus cornutus* (Linnaeus) and squirrel fish *Holocentrum rubrum* (Forskal), were recorded for the first time from Bombay, and other fishes, such as *Pomacanthus annularis* (Bloch) and *Chaetodon collaris* (Bloch) which are found only occasionally, were collected in large numbers.

* Not consulted in original.

At the same time, two specimens of the spiny lobster *Panulirus ornatus* (Fabricius) were also obtained from Bombay city, one from Chowpatty on 24-2-1962, and a larger one from Colaba on 21-5-1962. These were the only occasions during the last ten years when we have collected this species from Bombay. Enquiries made from fishermen along the coast of Maharashtra State have also indicated that it has never so far been collected by them.

PALINURIDAE

Panulirus ornatus (Fabricius)

Palinurus ornatus Fabricius, Suppl. Ent. Syst.: 400 (1798); De Haan, Fauna Japonica, Crust.: 157 (1841).
Palinurus (Panulirus) ornatus Miers, *Ann. Mag. nat. Hist.*, ser. 5, **5**: 378 (1880).
Palinurus homarus Pfeffer, *Mitt. naturh. Mus. Hamburg* **14**: 263 (1897).
Panulirus polyphagus Borradaile, Fauna Geogr. Maldive Laccad. Archipel. **2** (3): 754 (1904).
Panulirus ornatus Henderson, *Trans. Linn. Soc. London, Zool.*, ser. 2, **5**: 433 (1893); de Man, Siboga Exped. Rep. 39a2: 51 (1916); Holthuis, *Temminckia* **7**: 138 (1947); Barnard, *Ann. S. Afr. Mus.* **38**: 552 (1950).

The antennular plate bears four spines, the posterior two being only half as long as the anterior ones. A pair of denticles is present between them. The three spines on the fused coxicerites of the antennae present the same disposition as in *P. versicolor*, but the middle one is larger than the lateral ones. There is no flagellum on the exopodites of the second maxillipeds, these being tipped with a tuft of setae.

The three pairs of submedian spines in front of the cervical groove are slightly divergent, the three pairs behind this groove convergent, posteriorly. The groove on the posterior margin of the carapace is of the same width throughout. There are no transverse grooves on the abdominal segments.

The dimensions of the larger specimen are:

total length	280 mm.
length of carapace	115 mm.
length of supra-orbital spine	28 mm.

The cephalothorax has a bluish ground colour, while the spines are orange with golden tips. The antennular flagella are banded crimson-brown and cream. The supra-orbital spines have cream-coloured stripes.

The abdominal somites are olive-green, with a wide but faint black band on each segment. Laterally, a white streak and a cream oval-

shaped spot are present on each segment; the latter increases in width from the anterior to the posterior somites.

The telson, uropods, and abdominal appendages have a reddish tinge. The legs are banded brownish red and cream.

Distribution. Indo-Pacific. This species has been recorded from Bengal by Pfeffer (1897) and is known to extend from Karwar to Cape Comorin on the west coast of India. Chopra (1939) has recorded it as 'the common species of the Bombay coast'. In view of the fact that *Panulirus polyphagus* constitutes more than 99.7% of the lobster fishery around Bombay, this appears to be a case of mistaken identification.

Panulirus homarus-dasypus-burgeri complex

In their previous paper (1961) on the systematics of spiny lobsters of Bombay, the authors had recorded *Panulirus dasypus* (H. Milne-Edwards). This was differentiated from a related species popularly known as *Panulirus burgeri* (De Haan) by the shallow nature of the crenulations on the abdominal grooves, the latter being interrupted in the middle line, and by the absence of a flagellum on the exopodites of the second maxillipeds.

Gordon (1953) has pointed out the extent of variation in these characters in the two supposedly different species, as well as the difference in the size of the flagellum of the exopodites of the maxillipeds on the left and right sides in the same individual. These variations in the two species form a regular and overlapping series, and she concludes that they form a single variable species. De Bruin (1962) has also remarked on the variability of this feature.

Unless, therefore, other characters are found which are distinctly different in the two species, *Panulirus dasypus* must be merged with *Panulirus burgeri.*

Now, according to the law of priority, *Panulirus burgeri* is superseded by the name *Panulirus homarus,* as this species was named *Cancer homarus* as early as 1758 by Linnaeus, whereas the name *burgeri* was first used by De Haan only in 1841. (The name *dasypus* was applied first by H. Milne-Edwards in 1837.) Thus the lobster recorded by us from Bombay as *Panulirus dasypus* (H. Milne-Edwards) should properly be called *Panulirus homarus* (Linnaeus).

SCYLLARIDAE

This family is represented in Bombay waters by two species, *Scyllarus sordidus* (Stimpson) and *Thenus orientalis* (Lund). Both these squat lobsters migrate inshore in recognizable numbers during

winter, which appears to be their peak breeding season. During the rest of the year, they are quite rare, although their phyllosomae are available in plankton.

Scyllarus sordidus (Stimpson)

Arctus sordidus Stimpson, *Proc. Acad. Nat. Sc. Philadel.* : 23 (1860) ; de Man, *Zool. Jahrb. Abth. f. Syst.* T. **9** : 497 (1896) ; Nobili, *Boll. Mus. Torino* **18** (455) : 12 (1903).

Scyllarus sordidus de Man, Siboga Exped. Rep. 39a2 : 78 (1916) ; Prasad & Tampi, *Journ. Mar. biol. Assoc. India* **2** (2) : 250 (1960).

The body is moderately depressed, subcylindrical. There is no flagellum on the exopodites of the third maxillipeds. The rostrum is short and truncate. The proximal antennal squame is crossed on its dorsal surface by only one ridge. The anterior extremity of the sternum has a deep triangular notch.

The third pair of thoracic legs are not subcheliform. The abdominal terga are not deeply sulcate, and have a squamiform sculpture. The dactyli of the second pair of legs are longer and slenderer than those of the first. The calcified portion of the telson terminates in four teeth.

The dimensions of a berried female are:

total length (excluding antennal squame)	.. 57 mm.
length of carapace	.. 20 mm.

Colour muddy grey; there is a prominent dark red oval spot (fading to black on preservation) in the middle of the first abdominal segment.

Distribution. Hong Kong, Java Sea, Singapore. It has been previously recorded by de Man (1916) from the Gulf of Mannar and by Prasad & Tampi (1960) from the same area at Mandapam. This is the first record from the west coast of India.

Thenus orientalis (Lund)

Scyllarus orientalis Lund, *Skr. naturh. Selsk. Kbh.* **2** (**2**) : 22 (1793) ; De Haan, Fauna Japonica, Crust.: 150 (1841).

Thenus orientalis White, List Crust. Brit. Mus.: 67 (1847) ; Heller, *Reise Novara, Zool.*, **2** (3) : 93 (1865) ; Neumann, *Syst. Uebers. Oxyrh.*: 34 (1878) ; Ortmann, *Zool. Jahrb. Syst.* **6** : 46 (1891) ; Henderson, *Trans. Linn. Soc. London, Zool.*; ser. 2, **5** : 433 (1893) ; Thurston, *Bull. Madras. Govt. Mus.* **3** : 120 (1895) , Thompson, Catal. Crust. Mus. Dundee : 18 (1901) ; Alcock, Naturalist in Indian Seas : 68 (1902) ; de Man, Siboga Exped. Rep. 39a2 : 66 (1916) ; Holthuis, *Temminckia* **7** : 106 (1947) ; Barnard, *Ann. S. Afr. Mus.* **38** : 565 (1950) ; Prasad & Tampi, *Proc. nat. Inst. Sci., India* **B 23** : 48 (1957).

In this sole representative of the genus, the body is strongly depressed and lamellate, the carapace being broader than long. The

eyes are situated at the outer angles of the carapace. The margins of the carapace are indented, but not incised, at the cervical groove. The dorsal surface of the carapace and abdomen are studded with flattened granules or tubercles, which are in more or less transverse rows on the first five abdominal segments. The abdominal segments 2-5 have a slight median ridge, which ends in a sharp projecting point on the fifth segment. The fifth pair of legs in the female is not chelate.

The dimensions of a large-sized specimen are:

total length (excluding antennal squame)	240 mm.
length of carapace	95 mm.

Colour muddy grey.

Distribution. Mauritius, Red Sea, Persian Gulf, India, East Indies, Australia, China. It has been recorded from India by White (1847), Neumann (1878), Ortmann (1891), Thompson (1901), from Madras by Heller (1865), Henderson (1893), from the Orissa coast by Alcock (1902), and from Mandapam by Prasad and Tampi (1957).

ACKNOWLEDGEMENTS

The authors wish to express their grateful thanks to Dr. L. B. Holthuis, of the Rijksmuseum van Natuurlijke Historie, Leiden, Netherlands, and Dr. K. K. Tiwari, Superintending Zoologist, Zoological Survey of India, for their valuable suggestions. Thanks are also due to Dr. C. V. Kulkarni, Director of Fisheries, Maharashtra State, for facilities for work and to Dr. H. G. Kewalramani, Senior Scientific Officer, for critically going through the paper.

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13. ABNORMAL CELLS BUILT BY THE WASP *EUMENES ESURIENS* FABR. (?) : VESPOIDEA

(*With a plate*)

The commonest species of domestic mason wasp in New Capital, Bhubaneswar, is the little yellow, orange, black, and coral *Eumenes esuriens* Fabr. These wasps begin building their circular mud cells by laying down two brackets of mud. These brackets may both be laid on the same surface, but they are usually laid extending from a horizontal surface on to another surface at an angle to the first. The cells are thus commonly found in corners and chinks of masonry, and on door and window frames, rather than on walls. We have yet to find a nest not on a human artifact. Further loads are added to these two brackets extending them lengthways and raising their height. Usually a third bracket is added early in the process. These brackets are finally joined, the circular rim thus made is added to and thus reduced in circumference. The final one, or two, loads are bent outwards to make the well-known lip which acts as a funnel for introducing the prey, and the material of which is re-worked forming part of the lid when the cell is sealed. The number of loads used in such a construction ranges between 12 and 21, depending partly on the site and partly on the idiosyncrasy of a given wasp. Usually several cells are built overlapping one another, and then the whole construction is covered over with mud, partly as rough-cast, partly as vaulting. Of course a nest may be deserted at any stage. (A statistical analysis of nest building in this species is in preparation.)

If the almost inescapable comparison is made between these cells and a spherical water pot, it can be said that the wasps construct the upper part of a pot—say a third to a half—consisting of the shoulders, a barely distinct neck, and a lip. The lower edge of the shoulders is irregular in shape, fitting, and joined to, the substrate. One diameter is about 17 mm. and the other about 15 mm. There is some variation in size. However some species of *Eumenes,* for example the Indian *E. affinissima* (see Dutt 1913) and the European *E. dubius* and *E. pedunculatus* build cells which are complete spherical pots. The process is shown in the magnificent photographs of Olberg (1959, pp. 122-130). The wasps of these species lay down small flat plates of mud, rather narrowly attached to plants, extend them in diameter, curl up the edges into a saucer, then into a bowl, and finally into a narrow-mouthed pot with a typical lip.

Exceptional pots of wasp *Eumenes esuriens* (?)

1. View from above

2. View from below
Entire pot on right above and left below

On 24-9-63 a complete, slightly elliptical, sealed pot (No. *E. e.* 10 I) was noticed attached to a net curtain. The net was of pale green fibre glass basket weave and the cell was attached by a wide area of its curved flattish base to the hem at the top of the frill, where there were several layers of the fabric, and rows of machine stitching. About 23 cm. away on the same seam was an unfinished pot (presumably made by the same individual), an elliptical bowl (No. *E. e.* 10 II), of which the thick rounded base was visible from the inside. In shape, size, and texture these pots resembled the half cells built by *E. esuriens*. The Plate shows two views of each cell, cell I being on the right above and the left below. As the mud of the incomplete cell was dry, we assumed that the constructor of both cells had deserted, and collected the specimens.

A male *E. esuriens* (?) emerged from the complete pot on 8-10-63, i.e. in 14 days. The minimum developmental time we have observed has been 17 days in hotter weather (Jayakar & Spurway, in preparation).

There are at least two possibilities which would explain the building of these pots:

One. Different stimuli provided by the substrate evoke different building reactions in individuals of *E. esuriens* and perhaps other species. This is undoubtedly true in some respects, for without a capacity for variation, the usual half pots could not be constructed, *both* to fit their substrates, and to be species-specific in form. Indeed the capacity of surveying, of measuring the diameter of an area which is *to be* enclosed (which they can be seen doing with their antennae), and the laying of three foundations for it, implies nervous capacities much rarer than are implied by one sequence of instinctive movement being stimulated by one environment, and another sequence by another.

Two. Another domestic species very similar to *E. esuriens* exists, which invariably builds complete pots on non-rigid supports, and which may, or may not be distinguishable from *E. esuriens* morphologically, and by other traits of behaviour. It would presumably not form fertile hybrids with *E. esuriens*, which invariably builds half pots on rigid surfaces. The existence of such sibling species has been recognised by behavioural differences in the Sphecoid genus *Ammophila* (Adriaanse 1947).

The Bhubaneswar animals have so far only been identified by the authors, using the FAUNA OF BRITISH INDIA; a decision between the two possibilities, and certainty regarding the identification of the species, must await examination of the specimens by a taxonomist.

Iwata (1953) describes several Japanese species of *Eumenes* which have the capacity to form both half and complete pots. Others can make only one of the other. Fabre describes the same versatility in a European species but we have only seen his descriptions in popular extracts in English.

GENETICS AND BIOMETRY LABORATORY,
GOVERNMENT OF ORISSA,
BHUBANESWAR-3,

S. D. JAYAKAR
H. SPURWAY

BHUBANESWAR,
October 12, 1963.

C. R. MEEKER
J. E. MEEKER

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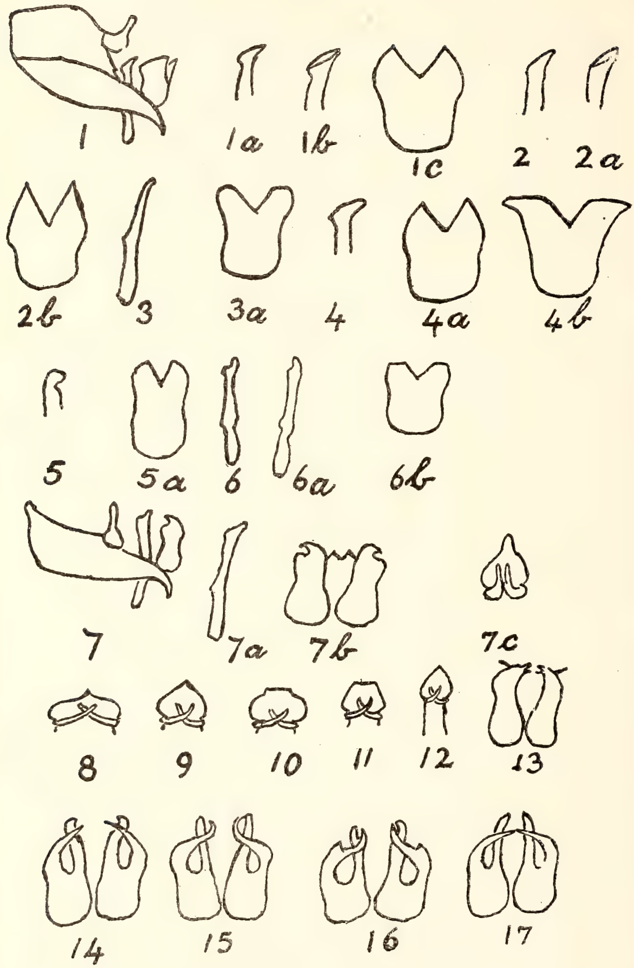
14. GENITALIA OF THE BUTTERFLY GENERA *SURENDRA* MOORE AND *EVERES* HÜBNER

(*With a plate*)

Surendra Moore. Only the upper part of the aedeagus is shown except in the cases of figures 3, 6, and 7 *a*. The outer side of the conjoined clasps is always shown, the clasps being pressed down on glass to straighten the edges which curl inwards. Fig. 1 is the armature of *vivarna quercetorum*; fig. 1 *a* is the correct view of its aedeagus; fig. 1 *b* is its aedeagus when tilted to or twisted from the observer or when viewed from slightly above. This view 1 *b* is frequent because the aedeagus is often twisted on its stem and gives a wrong idea of the true shape; again the orifice may be open and the true form of its edges cannot be seen. Fig. 1 *c* is its conjoined clasps. Fig. 2 is the correct view of the aedeagus of *vivarna vivarna*; fig. 2 *a* is the aedeagus when twisted away from or tilted towards the observer or when viewed from slightly above. The shape of aedeagus of both the above forms is like an inverted foot. *v. quercetorum* has a well-defined heel of the foot and a narrow toe tip while *v. vivarna* has an ill-defined heel, noticeable only on careful examination. The



Genitalia of the butterfly genera *Surendra* Moore and *Everes* Hübner

toe tip of *v. vivarna* seems slightly broader than that of *v. quercetorum* but it is hard to judge. The aedeagi of *v. discalis, v. biplagiata, v. latimargo, v. neritos* are similar to that of *v. quercetorum.* Fig. 2 *b* is the clasps of *v. vivarna* which seem to be always more pointed on the ventral edge than those of the other forms. Fig. 3 is the peculiar aedeagus of *v. manilana,* fig. 3 *a* is its clasps, which from a single dissection appear to have a very shallow cleft. Fig. 4 is the aedeagus of *v. amisena* which is wider at the tip than that of *v. quercetorum.* The figure serves also as the aedeagus of *v. agdistis* (which was to be expected) and of *v. samina* (which was not expected). Fig. 4 *a* is one form of its clasps and 4 *b* another form. In the genus *Narathura* (Arhopala Group) the clasps have been found so variable that genitalia are not a sure guide. *Surendra* is an allied genus and this variation may occur in other forms, not discovered in my few dissections. Fig. 5 is the aedeagus of *v. palowna,* unlike any other. Fig. 5 *a* shows its clasps as more slender than others. Fig. 6 is the slender aedeagus of *florimel* as seen in the armature and 6 *a* as seen on a card. The ecavation below the tip is seen on both. Probably fig. 6 is its true picture at exactly right angles to viewer and 6 *a* as it is turned slightly away. Such things explain why many correction slips are pasted in the key of the genus in my 1962 Revision of Evans' Lycaenidae 1932. Fig. 6 *b* is its clasps, low in height with a shallow cleft. Fig. 7 is the armature of *todara,* fig. 7 *a* the aedeagus, 7 *b* the clasps, and 7 *c* the inside of the uncus, which rises to a blunt point, while in all other forms in the genus it is flat.

The reasons why all, except *florimel* and *todara,* have been left as subspecies of *vivarna* are given in the note to my key referred to above. The aedeagus of *palowna* and *manilana* should qualify them for being species, but the shape of the aedeagus does not separate *samina* from *amisena,* though far removed in locality and different in facies.

Everes Hübner. Fig. 8 is the uncus of *buddhista shandura.* Fig. 9, uncus of *argiades diporides*—all ssp. of *argiades* have the uncus in shape like the ace of Hearts on a playing card. Fig. 10, uncus of *hugelii dipora* and of course of *hugelii hugelii.* Fig. 11 is the uncus of *lacturnus assamica.* Fig. 12, uncus of *kala,* narrow and with an elongated lower portion. Figures of all clasps are of the outsides of them. Fig. 13 is of those of *kala,* showing a peculiar needle-like process. Fig. 14 is of *buddhista shandura.* Fig. 15 is of *argiades diporides.* Fig. 16 is of *hugelii dipora,* showing the excavation at the tip of the straight style on the interior edge and the sudden

narrowing at right angles of the curling process. Fig. 17 is of *lacturnus assamica* and of all ssp. of *lacturnus*, showing how the straight style goes far beyond the sharp tip of the curled process. To know the genitalia of *argiades diporides* and of *hugelii dipora* is important as an *argiades diporides* with small spots below may be indistinguishable from a *hugelii dipora*. The nomenclature follows the key in my 1962 Revision of Evans' Lycaenidae 1932. It differs greatly from that of Evans 1932, one reason is because he described as *diporides* what was really *dipora* and vice-versa.

5, Upper Wimpole Street,
London, W. 1,
September 11, 1963.

KEITH CANTLIE

15. THE RED COTTON BUG [*DYSDERCUS CINGULATUS* (FABR.)] AND ITS PREDATORS

Mr. Sevastopulo's comments (*J. Bombay nat. Hist. Soc.* **60** : 466) on my note on the role of *Calotes versicolor* and *C. rouxi* as natural controls of the Red Cotton Bug [*Dysdercus cingulatus* (Fabr.)] are tinged with a certain amount of cryptic scepticism. I am surprised that such scepticism should emanate from so eminent an entomologist, for there is so much apparently 'incredible' in the field of entomology, nevertheless we must accept the statements of the observer. My statements on the food of the two species of *Calotes* were based on literally hundreds of observations in the field (sight records) and on scores of dissections of both species concerned.

It surprises me that Mr. Sevastopulo compares the enemy cycle of two very different insects from different continents, although the two belong to the same genus, and, further, the food cycles of two entirely different groups of animals, Reptilia and Amphibia, and those, too, from different continents.

Although *D. cingulatus* may be a 'perfect text-book illustration of an aposematic insect', like most other aposematic insects it is not immune against its *natural* enemies and controls. It is well known that most of the cuckoos feed on some species of Rhynchota and hairy caterpillars, which most other birds avoid; each species of cuckoo sticks to its particular species of food bugs regardless of their colouring, scent, or taste as the case may be. The periodic appearance of cuckoos invariably coincides with the appearance of the particular food supply (bugs and/or caterpillars) in the area visited—the life-cycles of the birds and the insect are closely linked. This interlocking

of life-cycles is even more common in the insect world, in which the appearance of certain insects is linked with the particular food plant.

It is incorrect that toads are 'the least discriminating of reptilian and amphibian insectivores'. Most reptiles and amphibians are fairly selective in their diet, although the menu may be very varied. Under normal conditions they avoid certain categories of insects. As moving objects are usually 'lapped up' by Amphibia (they seldom take a stationary object, even if it is normally eaten), they sometimes make 'mistakes' but the object is immediately spat out—such 'mistakes' may be repeated. Mr. Sevastopulo himself states that *Dysdercus* he observed (in Africa) attracted to light were 'almost always avoided by the attendant toads, but occasionally perhaps due to colour changes caused by the light one is caught and is then invariably spat out and the inside of the mouth scraped by the forelegs with every appearance of disgust'. This is one of those 'mistakes' under artificial lighting conditions—the initial action of the toad being prompted by the movement of the bug.

If my memory serves me right, *Dysdercus* is almost entirely a diurnal insect—it is certainly less active during the hours of darkness. On the other hand, the toad is a crepuscular or nocturnal feeder. Under ordinary circumstances the active cycles of the two animals would not coincide and, accordingly, the chances of *Bufo* meeting *Dysdercus* are comparatively rare.

In conclusion, I believe, that no form of protectively coloured, protectively shaped, or protectively scented insects are free from their natural enemies or controls, and that protective devices operate against would-be enemies only. The normal controls whose food such insects form are 'aware' or 'know' the devices, for their very existence is dependent on the food supply.

17, CLARKE STREET,
KHANDALLAH,
WELLINGTON, NO. 5,
NEW ZEALAND,
January 2, 1964.

CHARLES McCANN

16. THE GENUS *ZORNIA* GMEL. IN INDIA

Mohlenbrock in his monograph on the genus *Zornia* in *Webbia* **16** (1) : 1-141, 1961, pointed out that *Zornia gibbosa* Span. is the only species of *Zornia* found in India and that most specimens referable to this species have been called previously either *Zornia*

diphylla Pers. or *Zornia angustifolia* Sm. He contended that *Zornia diphylla* (L.) Pers. has a very limited range and that it is found only from Ceylon eastwards. This was obviously a geographical error and he agreed later on, in a personal communication to the author, that the geographical range of *Zornia diphylla* (L.) Pers. should be Ceylon and India (peninsular and south).

Mohlenbrock puts the two species, *Zornia diphylla* (L.) Pers. and *Zornia gibbosa* Span., in the subgenus *Zornia*, the former in the section *Isophylla*, the latter in *Anisophylla*. The two species can be distinguished as follows:

Perennial; lower and upper leaflets of the same shape, upper sometimes smaller in size; petiole longer than the leaflets; leaflets ovate to lanceolate-ovate; auricle of the bract epunctate; loment with 4 articles; articles 4.3-4.5 mm. long, 3.5 mm. broad, with nearly glabrous bristles 1.5-3 mm. long .. .. .. *diphylla*

Annual; lower and upper leaflets different in shape; petiole $\frac{2}{3}$rds to as long as the leaflets; leaflets lanceolate to linear; auricle of the bract punctate; loment with 4-6 articles; articles 2-2.5 mm. long, 2-2.5 mm. broad, with retrorsely hairy bristles 0.4-1.2 mm. long .. *gibbosa*

Zornia diphylla (Linn.) Pers. Syn. 2 : 318, 1807; Mohlenbrock in Webbia 16 (1) : 67, ff. 44 & 49, 1961. *Hedysarum diphyllum* Linn. Sp. Pl. 747, 1753. *H. conjugatum* Willd. Sp. Pl. 3 : 1178, 1800. *Zornia zeylonensis* Pers. Syn. 2 : 318, 1807; Gamble, Fl. Pres. Madras (reprint ed.) 1 : 229, 1957. *Z. conjugata* (Willd.) Sm. in Rees, Cycl. 39 : 3, 1819; Santapau in Rec. Bot. Surv. India 16 (1) (ed. 2) : 53, 1960. *Z. diphylla* var. *zeylonensis* Benth. in Mart. Fl. Bras. 15 (1) : 82, 1859; Baker in Hook. f. Fl. Brit. Ind. 2 : 148, 1876; Cooke, Fl. Pres. Bombay (reprint ed.) 1 : 356, 1958.

Distribution in World. Ceylon, India.

Zornia gibbosa Span. in Linnaea 15 : 192, 1841; Mohlenbrock in Webbia 16 (1) : 112, ff. 44 & 76, 1961. *Z. graminea* Span. in Linnaea 15 : 192, 1841. *Z. angustifolia* Sm. in Rees, Cycl. 34 : 1, 1819 pro maiore parte (nom. illeg.). *Z. diphylla* auct. plur (non Pers. 1807); Baker in Fl. Brit. Ind. 2 : 147, 1876; Prain, Beng. Pl. 1 : 416, 1903. Cooke, Fl. Pres. Bombay (reprint ed.) 1 : 355, 1958; Gamble, Fl. Pres. Madras (reprint ed.) 1 : 229, 1957; Haines, Bot. Bih. & Or. (reprint ed.) 2 : 263, 1961; Duthie, Fl. Upp. Gang. Plain (reprint ed.) 1 : 247, 1960; Santapau, Fl. Purandhar 40, 1958; Santapau in Rec. Bot. Surv. India 16 (1) (ed. 2): 53, 1960; Santapau, Fl. Saurashtra 1: 142, 1962.

Distribution in World. Pakistan, India, Burma, Celebes, China, Cochinchina, Malaya, Philippine Islands, Siam, New Guinea and Australia.

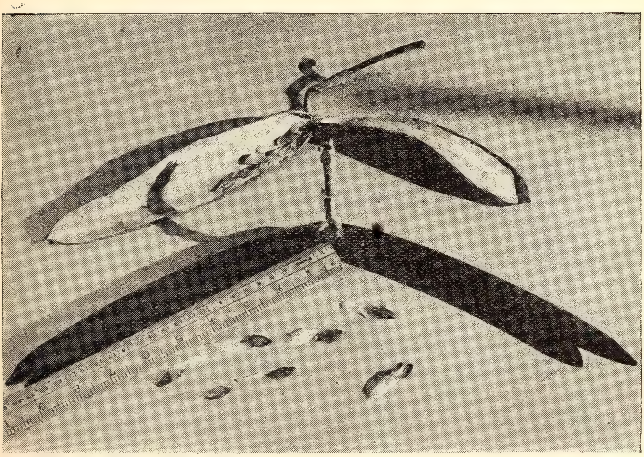
BOTANICAL SURVEY OF INDIA,
14, MADAN STREET,
CALCUTTA 13,
October 19, 1963.

S. K. WAGH, Ph.D.

17. FRUITING OF *PLUMERIA*

(*With a photograph*)

Plumeria, commonly known as the Frangipani, Pagoda Tree, *Gul-e-chin,* etc., is a small tree, a native of Tropical America introduced into India a long time ago. It is one of those exotics which do not normally set seed or bear fruits in India, hence its propagation has all along been by stem cuttings. Fruiting here is in fact so scarce that one may not come across a fruiting *Plumeria* all his life.



Plumeria acutifolia Poir.

Showing 24 cm. long follicular fruit, dehiscing fruit, and winged seeds

It will, therefore, be interesting to note that trees of a variety of *Plumeria acutifolia* Poir., whose flowers have half the underside of each petal a bright rose colour and the other half white, growing in the garden of the Forest Research Institute have been bearing fruits profusely for about 15 years. The fruits are stout, twin follicles containing winged seeds, ripening on the tree itself, and dehiscing in early summer.

Eminent botanists in India have invariably hinted at the extreme rarity of fruiting in *Plumeria*, and the length of fruit is given as up to 12.5 cm. only. However, the trees of *Plumeria* under reference, not only bear fruit regularly and profusely but also the length of the fruits is nearly double than that recorded before. The ones photographed here measure 24 cm. and there is a possibility of some being a little longer.

This note is therefore a record of the fruiting of *Plumeria* in northern India and the length of the fruits.

FOREST RESEARCH INSTITUTE,
P.O. NEW FOREST, K. M. VAID
DEHRA DUN,
October 15, 1963.

[The taxonomy of the genus *Plumeria* is somewhat complicated, and it would be of interest to know the exact variety of the plant mentioned in this note. Some of the varieties or forms that go under *P. acutifolia* Poir. have been known in Bombay to flower and fruit more or less regularly.—EDS.]

18. *BOERHAVIA PUNARNAVA* SAHA ET KRISHNAM. : A NEW RECORD FOR KERALA STATE

Recently Saha & Krishnamurthy described a new species of *Boerhavia* from Pondicherry and its neighbourhood, namely *B. punarnava* in 1962, *J. Sci. Indust. Res.* **21** C : 249. As the species has not been reported from any other part of the country a record of it from Kerala State was considered to be of interest. The taxon can be easily distinguished from the common *B. diffusa* Linn. by its stalked pinkish white flowers in umbelliform clusters, obconical non-glandular fruit with a truncate crown, and anthocarp with transverse wrinkles. The plant is common in the Port of Cochin, particularly along railway tracks. The specimens mentioned in this note are kept

in the Herbarium of Botanical Survey of India, Northern Circle, Dehra Dun.

Specimens examined: *N. C. Nair* 1155, 1160 (April 1961); *V. J. Nair* 28497, 28498 (Sept. 1963).

BOTANICAL SURVEY OF INDIA,
DEHRA DUN,
October 14, 1963.

N. C. NAIR
V. J. NAIR

19. *BOERHAVIA PUNARNAVA* SAHA & KRISHNAM. : A NEW RECORD FOR MAHARASHTRA

(*With four text-figures*)

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Boerhavia punarnava

The present author collected a few plants of white-flowered *Boerhavia*, with flowers and fruits, growing as a weed in a local garden during this rainy season. The general characters of this plant

agree with the description given for *B. punarnava* Saha & Krishnam. to a great extent but show some minor differences.

The stem which is distinctly pinkish in the lower portions gives rise to 3-6 prominent branches from some distance above the ground. The younger portions of the branches gradually become green. The main root before entering deeper into the soil gives rise to 3-4 strong branches. Leaves are simple and are arranged in unequal pairs. The nodes are distinct. There is a great amount of variation in size and shape of the leaf (Fig. 1). Generally the length of the leaves varies from 1 to 4 cm. and breadth 0.5 to 3 cm. But still the undersurface of the lamina is whitish. Some of the lower leaves of the younger plants show a pinkish coloration on the undersurface. Sometimes the main veins are also pinkish. Inflorescence is extensively branched. Flowers are arranged in groups of 1-3 (Fig. 2). The flowers when open are distinctly white but very young flower buds are pinkish. The corolla-tube has pinkish lines on the dorsal side as described by Saha & Krishnamurthy. Stamens are 1 or 2. The present author was not able to see flowers with 3 stamens as reported by Saha & Krishnamurthy (1962)[1]. Flowers with two stamens are very common. The description given by Saha & Krishnamurthy (1962) for the fruits of *B. punarnava* exactly tallies with the characters shown by the fruits of this plant.

As far as the author is aware, *Boerhavia punarnava* Saha & Krishnam. is reported for the first time from Maharashtra.

RAMNIRANJAN JHUNJHUNWALA
ARTS & SCIENCE COLLEGE,
GHATKOPAR,
BOMBAY 77,
October 19, 1963.

S. RAMARETHINAM, M.SC., Ph.D.

20. *DENDROPHTHÖE FALCATA* (LINN. F.) ETTINGSH. : A METHOD OF CONTROL

Your remarks on the note published by Srivastava (1963) on 'Hosts of *Dendrophthöe falcata* (Linn. f.) Ettingsh.' in your journal (*J. Bombay nat. Hist. Soc.* **60** : 474-475) have prompted me to write the following.

---

[1] Saha, J.C., & Krishnamurthy, K.H. (1962): Identity of the Sweta Punarnava *Boerhaavia punarnava* sp. nov. of the Ayurveda. *J. Sci. Industrial Res.* **21**C : 249-255.

Name of host	No. of parasites killed			Family of host
	Up to 8-5-62	Up to 11-12-63	Total	
1. *Achras sapota* Linn. ..	26	10	36	Sapotaceae
2. *Aegle marmelos* Correa ..	2	0	2	Rutaceae
3. ** *Artocarpus heterophyllus* Lamk. ..	7	0	7	Moraceae
4. *Bauhinia variegata* Linn. ..	8	10	18	Leguminosae
5. *Callistemon lanceolatus* Sweet FP. ..	16	42	58	Myrtaceae
6. * *Casuarina glauca* Sieber ..	..	10	10	Casuarinaceae
7. ** *Citrus limon* (L.) Burm f.	3	16	19	Rutaceae
8. ** *Ficus carica* Linn. ..	6	0	6	Moraceae
9. ** *Gardenia lucida* Roxb. ..	..	5	5	Rubiaceae
10. * *Gmelina arborea* Roxb. ..	..	4	4	Verbenaceae
11. *Grevillea robusta* A. Cunn.	2	4	6	Proteaceae
12. ** *Lagerstroemia lanceolata* Wall. ..	15	0	15	Lythraceae
13. *Lagerstroemia thorelii* Gagnep. ..	..	13	13	Lythraceae
14. ** *Malpighia glabra* Linn. ..	1	0	1	Malpighiaceae
15. *Mangifera indica* L. ..	865	843	1708	Anacardiaceae
16. ** *Morus alba* L. ..	3	18	21	Moraceae
17. *Olea cuspidata* Wall. ..	18	0	18	Oleaceae
18. ** *Prunus padus* Linn. ..	2	0	2	Rosaceae
19. ** *Psidium guajava* Linn. ..	59	0	59	Myrtaceae
20. * *Shorea robusta* Gaertn. ..	..	18	18	Dipterocarpaceae
21. ** *Syzygium jambolanum* DC.	1	0	1	Myrtaceae
22. *Terminalia muelleri* Benth. ..	10	8	18	Combretaceae
Grand total ..			2034	

Investigations on the control and eradication of Bandha, *Dendrophthöe falcata* (Linn. f.) Ettingsh., were started ten years ago

and positive results have been achieved (Singh 1957, 1958). Experiments at the National Botanic Gardens, Lucknow, succeeded in eradicating 1043 parasites from different hosts as reported by Singh (1962). Work since this report is continued and some new hosts have been included in the list. Up to date, three new hosts have been treated successfully at the National Botanic Gardens, in addition to the earlier mentioned ones on which fresh parasitic attack has been checked. The total number of parasites killed so far is 2034. The table on p. 219 gives the list of hosts which have been treated successfully.

A. This list would incidentally show that Srivastava has not mentioned some other hosts marked ** from which the parasite, once abundant, has been killed in the majority of cases.

B. Of the list of new hosts reported by him, those marked * have been subjected to successful treatment.

The remedial measures adopted (Singh 1955, 1957, 1958, 1962) are simple as well as cheap consisting of Diesel or Powerine oil emulsions of varying strength (30-50%) sprayed on the parasites, which are killed in 2 to 4 months' time and may even fall down from the tree in due course leaving rose-wood scars on the host. This is mostly possible by a single spray. This variation in the strength of spray arises out of several factors: (*a*) in hot, sunny weather a lower percentage of the parasiticidal emulsion kills the parasite; (*b*) in cold weather on the other hand the emulsion has to be of a stronger consistency; (*c*) because of the physiologic forms which exist in the parasite a change in the strength of emulsion may sometimes be necessary (Singh 1958, 1962); and (*d*) also on account of the comparatively susceptible nature of some hosts to higher concentrations of these parasiticidal emulsions (Singh 1957) sprays of weaker consistency have to be used and may in such cases have to be applied more than once.

The parasitic onslaught which appears to be on the increase (Santapau 1954; Chavan & Oza 1963; Srivastava 1963) is due to dissemination of the seeds by birds and squirrels who eat the fruits and discard the seeds uninjured (Fischer 1926; Ridley 1930; Ali 1931; Danser 1931, 1933; Singh 1952, 1954, 1962). On account of this fact, although the onslaught of the attack of *Dendrophthöe* can be kept under check, its total elimination is only possible either by destroying the birds and squirrels who carry the seeds or at the Government level by an organization like the Plant Protection Organization of the country, that is in a position to undertake the spraying on wide

areas throughout the country. The former remedy would, however, prove to be disastrous as it may even change the biology of the forest. The only other alternative, therefore, would be for the scheme to be handled by the Plant Protection Organization or some other organization sponsored by the Government.

Village orchardists should also be apprised of the remedy for keeping the destructive parasite in check. If a regular enquiry is made from the Horticulture and the Forest Departments of the extent of damage caused by this parasite, as well as other loranthaceous ones, a revealing and true picture would be available to the Government of the colossal losses to which are subjected our Teak, Sal, and myriads of other forest trees as well as the fruit trees in this country.

NATIONAL BOTANIC GARDENS, BAHADUR SINGH
LUCKNOW, *Assistant Director*
December 18, 1963.

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[We are glad to learn from Dr. Singh's note that there is a continuing campaign against this parasite and apologise for our suggestion to the contrary at page 475 of the *Journal* for August 1963.—EDS.]

21. TOXICITY OF YELLOW OLEANDER *THEVETIA PERUVIANA*

Two notes appeared in *Journal Bombay Natural History Society*, (i) Reuben, D. E. **58** (3) : 808 and (ii) Chatterjee, S. K. **59** (3) : 947, wherein they speak of 'predators of Yellow Oleander (*Thevetia neriifolia*)' fruit and note that the animals which ate it were devoid of any toxicosis as they continued eating the fruit.

Although it has been mentioned that all the parts of the plant are poisonous, it does not mean that all the parts of the plants are equally poisonous. There has been a mention of the use of this plant, especially the juice of the leaves, for so-called abnormalities of 'Kafa' in Ayurveda. As a potion it has been recommended for the treatment of skin conditions and as a collyrium for impairment of vision. That this has been mentioned in Ayurveda suggests that our ancestors were aware of its toxic and pharmacological properties. I myself have not seen any animal or bird constantly eating the seeds of *Thevetia peruviana* [=*T. neriifolia* (Pers.) Merr.] but while collecting these seeds for experimental purposes, we found some seeds which appeared to have been nibbled either by birds or squirrels.

The fruit consists of an outer fleshy portion containing a milky juice, which is a gastric irritant and causes nausea and vomiting in human beings, yet is not capable of producing any severe degree of systemic toxic reactions. Inside this fleshy portion, which becomes black and shrunken on full ripening or on drying, is a fairly hard shell. When this shell is broken one gets 2 to 3 kernels. It is these kernels which are highly poisonous and are utilised by many in this part of the country as a poison. We have seen some cases wherein the patients have taken either the leaves or only the fleshy portion of the fruit, throwing the kernels away. These patients only vomit as a result of gastritis, and other systemic toxic reactions are absent. Patients do not die of poisoning by eating merely the outer fleshy portion of the seed.

We have observed more than 150 patients in the last four years of whom a great many took these kernels for suicidal purposes. Roughly these kernels have two types of substances, (1) the fat soluble oily portion which is very toxic to the gastric mucosa and causes intense vomiting, and (2) the active glycosides which produce varying degree of heart block. Death is due to the sudden stoppage of the heart as a result of block in the conduction system of the heart.

However, due to the persistent vomiting, the patients' condition is further aggravated by extensive water and electrolyte loss.

HEAD, DEPT. OF MEDICINE,
MEDICAL COLLEGE,
PONDICHERRY, S. INDIA,
November 28, 1963.

D. B. BISHT, M.D.

22. SOME SOUTH INDIAN MOSSES

An enumeration of 368 species of mosses from the Palni Hills was published in Vol. **58** : 13-47, 1961, of this *Journal.* The present list is a supplement to it, consisting of the names of species collected by the author elsewhere from S. India. Species and varieties originally described as new taxa for these parts of India are preceded by an asterisk (*).

369. **Anomobryum auratum** (Mitt.) Jaeg.
Courtallam, Tirunelveli, 1929.

370. **Archidium birmanicum** Mitt.
Kankanady, Mangalore, 1925; Madras, 1926.

371. **Barbula consanguineus** (Thw. & Mitt.) Sb.
Kumili, Kerala, 1924.

372. **Brachymenium extenuatum** (Mitt.) Jaeg.
Madras, 1926.

373. **Bryum coronatum** Schwgr.
Kankanady, Mangalore, 1925; Kumili, Kerala, 1924.

*374. **Bryum euryphyllum** Dix. & Varde in *Arch. Bot.* **1** : 170, 1927.
Kumili, Kerala, 1924.

375. **Bryum plumosum** Doz. & Molk.
Kodaikanal, 1912.

*376. **Calymperes mangalorensis** Dix. & Varde in *Arch. Bot.* **1** : 164, 1927.
Kankanady, Mangalore, 1925.

*377. **Calymperes microdictyon** Dix. & Varde in *Ann. Crypt. Exot.* 3 (4) : 172, 1930.
Kodaikanal, 1927.

378. **Calymperes tenerum** C. M.
Courtallam, Tirunelveli, 1929.

379. **Calyptothecium patulum** (Broth.) Fl.
Sirumalai Hills, 1927.

380. **Campylodontium khasianum** C. M.
Perumalmalai, Kodaikanal, 1926.

*381. **Campylodontium perplicatum** (Ther. & Varde) Broth. in *Rev. Bryol.* **50** : 75, 1923.
Kodaikanal, 1921.

*382. **Campylopus introflexus** (Hedw.) Mitt. var. **vellei** Card.
Kodaikanal, 1921.

*383. **Ceratodon purpureus** Brid. var. **madurensis** Varde
Kodaikanal, 1912.

384. **Didymodon gemmiferus** Card.
Shembaganur, 1911.

385. **Erpodium mangiferae** C. M.
Mundanthurai, Tirunelveli, 1928.

*386. **Fissidens amplifolius** Dix. & Varde in *Ann. Crypt. Exot.* **3** (4) : 170, 1930.
Mundanthurai, Tirunelveli, 1928.

387. **Fissidens crocatus** C. M.
Courtallam, Tirunelveli, 1929.

388. **Fissidens atrovirens** Card.
Kodaikanal, 1909.

389. **Fissidens immutatus** Dix.
Kankanady, Mangalore, 1925.

390. **Fissidens lutescens** Broth.
Kankanady, Mangalore, 1925 ; Courtallam, Tirunelveli, 1929.

391. **Fissidens microcladus** Thw. & Mitt.
Mundanthurai, Tirunelveli, 1927.

392. **Fissidens xiphioides** Fleisch.
Kankanady, Mangalore, 1925.

393. **Fissidens zippelianus** Doz. & Molk.
Tovaiparai Shola, 1926 ; Manalur, 1927 ; Sirumalai Hills, 1927.

*394. **Garckea abbreviata** Dix. & Varde in *Arch. Bot.* **1** : 163, 1927.
Kankanady, Mangalore, 1925.

395. **Garckea phascoides** (Hook.) C. M.
Mangalore, 1927.

396. **Glossadelphus subretusus** (Mitt.) Fl.
Shembaganur, 1929.

397. **Grimmia nilghiriensis** C. M.
Kodaikanal, 1912.

*398. **Herpetineuron toccoae** (Shull. & Lesq.) Card. var. **excurrentinerve** Card. & Dix.
Shembaganur, 1911.

399. **Hookeriopsis percomplanata** Card.
Kodaikanal, 1912.

*400. **Hyophila grandiretis** Dix. & Varde in *Arch. Bot.* **1** : 166, 1927.
Poonamalai Road, Madras, 1926.

*401. **Hyophila nitidifolia** Dix.
Kodaikanal, 1912.

402. **Hyophila spathulata** (Harv.) Jaeg.
Somerford, Madras, 1925.

*403. **Leucoloma brevifolium** Dix. & Varde in *Ann. Crypt. Exot.* 3 (4) : 170, 1930.
Courtallam, Tirunelveli, 1929.

*404. **Macromitrium binsteadii** Dix.
Courtallam, Tirunelveli, 1929.

*405. **Macromitrium polygonostomum** Dix. & Varde in *Arch. Bot.* **1** : 170, 1927.
Sirumalai Hills, 1927.

*406. **Merceyopsis spathulifolia** Dix. & Varde in *Arch. Bot.* **1** : 164, 1927.
Kankanady, Mangalore, 1925.

*407. **Meteorium atratum** (Mitt.) C. M. var. **crassicladum** Card.
Kodaikanal, 1912.

*408. **Papillaria tumida** Card. in *Rev. Bryol.* **50** : 73, 1923.
Kodaikanal, 1912.

*409. **Philonotis subrigida** Card. var. **adpressa** Card. & Varde
Kumili, Kerala, 1924.

*410. **Physcomitrium coorgensis** Broth.
Sirumalai Hills, 1927.

*411. **Physcomitrium insigne** Dix. & Varde in *Arch. Bot.* **1** : 168, 1927.
Kumili, Kerala, 1924.

412. **Pottia vernicosa** (Hook.) Hampe
Madras, 1926

*413. **Rhaphidostegium camptocladum** Card.
Kodaikanal, 1924.

*414. **Rhynchostegium brachythecioides** Dix. & Varde in *Arch. Bot.* **1** : 173, 1927.
Sirumalai Hills, 1924 ; Periyur, 1927.

415. **Stereophyllum ligulatum** (C. M.) Jaeg.
Kankanady, Mangalore, 1925.

416. **Taxithelium nepalense** (Schw.) Broth.
Courtallam, Tirunelveli, 1929.

*417. **Thysanomitrium involutum** (C. M.) Card.
Kodaikanal, 1912.

*418. **Trachyphyllum inflexum** (Harv.) Gepp. var. **patentifolium** Dix. & Varde in *Ann. Crypt. Exot.* 3 (4) : 181, 1930.
Mundanthurai, Tirunelveli, 1928.

419. **Trachypodopsis crispatula** (Hook.) Fl.
Kodaikanal, 1912.

*420. **Trachypus hispidus** (C. M.) Par. var. **adpressa** Card.
Perumalmalai, 1927.

*421. **Trachypus massartii** Ren. & Card.
Kodaikanal, 1912.

*422. **Trachypus subpiliferus** Card.
Kodaikanal, 1912.

423. **Trachypus tenerrimus** Broth.
Tovaiparai Shola, 1927.

424. **Vesicularia reticulata** (C. M.) Broth.
Sirumalai Hills, 1924.

SACRED HEART COLLEGE,
SHEMBAGANUR P.O.,
MADURAI DISTRICT, SOUTH INDIA,
November 22, 1963.

G. FOREAU, S.J.

ANNUAL REPORT OF THE BOMBAY NATURAL HISTORY SOCIETY FOR THE YEAR 1963-64

EXECUTIVE COMMITTEE

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Y. S. Shivrajkumar of Jasdan	*Jasdan*
Mr. P. D. Stracey, I.F.S.	*Shillong*
Lt. Gen. Sir H. Williams, C.B., C.B.E., M.I.C.E., M.I.E, ...	*Roorkee*

HONORARY SECRETARY'S REPORT FOR THE YEAR 1963

At the last Annual General Meeting of the Society held on 31st May 1963 we presented a report about the activities of the Society up to April 1963. The present report covers the eight months thereafter up to 31st December 1963.

The Society's Journal

Two numbers of the Journal Vol. 60, Nos. 1 and 2, were published during the period under report. The 506 pages include 7 papers on birds, 6 on botany, 2 each on reptiles and amphibia, Annelids and Molluscs, and one each on mammals and insects. 43 Miscellaneous Notes covered many subjects and, together with the papers, included descriptions of several new species and races of various animals. Complaints are often made that the *Journal* is becoming too technical and that from the point of view of the general naturalist it is not as lively as it used to be. This fact is unfortunately true but the editors are not in a position to remedy the situation until members send in more articles of general interest from time to time.

General

New Building. The main structural work on the new building was completed and Rs. 2,00,000 received from the Government of India out of a total estimated cost of Rs. 3,30,343. Every effort is being made to complete the building before June 1964.

BNHS/WHO Bird Migration Study Project. Three camps were held at Hingolgadh, Bharatpur, and Kerala during the period under report. At the Hingolgadh camp held for ten days in September 153 migrants were ringed. At Bharatpur (September 21st/October 13th 1963) 2782 migrants and at Kerala (November 1963/February 1964) 21,920 migrants were ringed, mainly wagtails with lesser numbers of swallows, buntings, and other species. Blood samples of migrant species were collected at Bharatpur and Kerala for virological investigation, by Dr. Levkovitch of Kievskae Shosee Institute of Poliomyelitis and Virus Encephalitis, Moscow, USSR. Two interesting recoveries in Kerala were of wagtails ringed at Bharatpur and Calcutta during previous sessions. The possibility of ringing migratory waterfowl and waders in Bihar was explored by one of the research students who has successfully ringed over 900 migrants.

Talks and Film Shows. Five meetings were held at the Society's rooms during the period under report at which Dr. Sálim Ali spoke on ' Significant Books of Natural History ', Rev. E. M. Shull on ' Indian

Butterflies and Moths', Mr. Mahinder Lall on Bhutan, Mr. Zafar Futehally on 'Nature Conservation', and Dr. (Miss) G. Dücker on 'Colour Vision in Animals'.

New Additions to our Collection. During the year 177 additions were made to our registered collection of vertebrates—88 birds, 1 mammal, 42 reptiles, and 46 amphibians. Interesting additions are :

Mammal

Tadarida teniotis (European Freetailed Bat)

Bird

Bradypterus major

Reptiles

Eretmochelys imbricata
Teratoscincus microlepis
Stenodactylus orientalis
Gymnodactylus rubidus
Cnemaspis wynadensis
Gehyra mutilata
Phelsuma andamanense
Teratolepis fasciata
Goniocephalus subcristatus
Lygosoma dussumieri

Library. During the year 52 books were added to the library of which 8 were purchased, 17 received for review. 27 books and 41 journals were received as donations. Our thanks are due to the donors.

PUBLICATIONS

The printing of the revised edition of THE BOOK OF INDIAN ANIMALS was taken in hand and it is hoped that it will be ready during 1964. We have to thank Sir Keith Cantlie for bearing the cost of publishing his REVISION of the Lycaenidae portion of Evans's IDENTIFICATION OF INDIAN BUTTFRFLIES. The seventh edition of THE BOOK OF INDIAN BIRDS is in the press and is expected to be ready in 1964. We are considering publication of a revised version of Col. Wall's COMMON INDIAN SNAKES.

As usual the Society published a Nature Calendar which was greatly appreciated by members and proved popular with many business firms as well.

A Hindi edition of THE BOOK OF INDIAN BIRDS by Sálim Ali similar in format to the English edition is being prepared by the Central Hindi Directorate, Government of India.

We are happy to report that the Government of India have provided a grant-in-aid for the HANDBOOK OF INDIAN BIRDS which is now under preparation by Dr. Sálim Ali and Dr. Sidney Dillon Ripley. Our Society is sponsoring this publication. It will be in about 10 volumes and will illustrate every species in colour. It is designed for the field naturalist as well as for the museum worker and will be an extremely valuable addition to ornithological literature.

NATURE EDUCATION SCHEME

The Nature Education Scheme financed by the Government of Maharashtra is now in its 16th year. Tours of the Natural History Section of the Prince of Wales Museum and special talks on natural history subjects with the aid of exhibits and other specimens, films, and living animals were continued. The activities under the Scheme have now been extended to Poona and the revised General Science Syllabus prepared by the Society's Nature Education Committee giving importance to the study of the natural environment has been adopted by many schools in Bombay and Poona.

MEMBERSHIP

The total membership on our books at the end of 1963 was 1284, including 242 life and 4 honorary members. Subscriptions were received from 741 members, and we hope to receive subscriptions from most of the remaining 297 members, except for a few who cannot be traced. During 1963, 98 ordinary members and 3 life members were enrolled as against 32 members who resigned, or died. We would like to enlist your help in enrolling more members. As you know, the annual subscription has remained unchanged since 1949 and unless there is a substantial increase in membership we will be unable to cover our deficit in the future.

FIELD TRIPS

In October two Research Assistants were sent to the Laccadives for investigating the possibilities of ringing breeding sea birds. The report of their activities will be found in a later issue[1] of the *Journal.*

REVENUE ACCOUNT

During the year under review the income of the Society, excluding the special grant received from the Government of Maharashtra for the maintenance of the Reference Collections, was Rs. 69,058.70 as against Rs. 54,223.96 in the previous year. The working of the Society during 1963 showed a deficit of Rs. 8,324.25 as against Rs. 5,632.94 in 1962.

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[1] See p. 185 above.

Staff

The Committee wishes to record its appreciation of the willing co-operation of the entire staff in the activities of the Society.

Acknowledgements

The Committee's thanks are due to Mr. J. L. Bernard who continues to look after the Society's interests in the United Kingdom.

SUPPLEMENTARY REMARKS FOR THE PERIOD JANUARY TO APRIL 1964

Journal

The December 1963 issue of the *Journal*, completing Volume 60, contained 260 pages and included three articles each on birds and botany, two on Crustacea, and 1 each on mammals, amphibians, insects, and general natural history. It contained 22 Miscellaneous Notes on various subjects.

General

New Building. The Government of India have made a further grant of Rs. 1,00,000 towards the cost of the building.

Talks and Film Shows. We arranged a film show on the 27th March at the Society's premises. Two films RUTHLESS ONE and LIVING SOIL were kindly lent by Messrs Burmah Shell, and the films were greatly appreciated.

Field Trips. Mr. Humayun Abdulali spent a month in the Andaman Islands with the Society's Field Assistant Mr. P. B. Shekar and Mr. L. B. Nogueira of the Prince of Wales Museum, who were loaned to him. He obtained some 256 birds of about 100 species and subspecies together with other natural history specimens which he has presented to the Society. These will form a useful supplement to our collections which have very few specimens from that area. We hope to publish a report on the trip and the collections in due course.

Registered No. F 244 (BOM)

THE BOMBAY NATURAL HISTORY SOCIETY

THE BOMBAY PUBLIC TRUST ACT 1950
SCHEDULE VII [VIDE RULE 17 (1)]

BALANCE SHEET AS AT 31 DECEMBER 1963

FUNDS AND LIABILITIES		Rs. nP.	Rs. nP.
Trust Fund or Corpus:			
Life Membership Fund			
Balance as per last Balance Sheet ..		74,445.28	
Add: Amount received during the year		1,950.00	
			76,395.28
Fixed Assets Fund:			
Balance as per last Balance Sheet	60,763.88		
Less: Depreciation adjusted	8,861.37		
			51,902.51
Other Earmarked Funds:			
Field Work Fund ..			
Balance as per last Balance Sheet	1,489.79		
Add: Amount received during the year ..	3,000.00		
	4,489.79		
Less: Spent during the year	890.65		
		3,599.14	
Wild Life Fund			
Balance as per last Balance Sheet	217.39		
Less: Spent during the year	115.96		
		101.43	
Carried forward ..		3,700.57	1,28,297.79

ASSETS	Rs. nP.	Rs. nP.
Immovable Properties:		
Motor Car		
Balance as per last Balance Sheet ..	15,490.00	
Less: Depreciation during the year ..	3,098.00	
		12,392.00
Furniture, Fixtures, & Equipment:		
Balance as per last Balance Sheet ..	46,107.00	
Less: Depreciation during the year ..	5,763.37	
		40,34 .63
Copyright Account		
Balance as per last Balance Sheet ..	5,184.34	
Less : Written-off towards the cost of 'Book of Indian Animals' 2nd Edition	5,184.34	..
Investments: (At Cost)		
Rs. 14,000 4% Bombay Port Trust Bonds .. 10,780.00		
Rs. 12,000 4% Bombay Improvement Trust Bonds .. 9,120.00		
Rs. 36,000 3% Funding Loan 1966/68 .. 35,812.62		
Rs. 25,000 3% Conversion Loan 1946 .. 25,000.00		
Carried forward ..		52,735.63

15A

BALANCE SHEET AS AT 31 DECEMBER 1963—(*continued*)

FUNDS AND LIABILITIES		Rs. nP.	Rs. nP.
Brought forward ..			1,28,297.79
Other Earmarked Funds—B/F ..		3,700.57	
Expedition Fund			
Balance as per last Balance Sheet		1,800.00	
Mammal Survey Fund			
Balance as per last Balance Sheet	1,089.11		
Less: Spent during the year	917.82		
		171.29	
Building Fund			
Balance as per last Balance Sheet		30,000.00	
Publication Fund			
Balance as per last Balance Sheet		30,725.00	
Unspent Grant Government of Maharashtra			
1960-61 Unspent Balance B/F	842.47		
Less: Refund to Government during the year ..	842.47		
		..	
1961-62 Unspent Balance B/F		348.75	
1962-63 Unspent Balance B/F	9,205.30		
Add: Amount advanced by the Society ..	471.55		
	9,676.85		
Less: Spent during the year (as per Income and Expenditure Account)..	9,676.85		
		..	
Carried forward ..		66,745.61	1,28,297.79

ASSETS			Rs. nP.	Rs. nP.
Brought forward ..				52,735.63
Investment (At Cost)—(Contd.) ..				
Rs. 2,000 3% 1st Development Loan 1970/75.		1,948.75		
Rs. 89,000		82,661.37		
(Market Value Rs. 78,403.50) ..				
Rs. 3,000 *Add*: 12 Years National Defence Certificates		3,000.00		
92,000		85,661.37		
£460 3½% Defence Bonds At Cost		6,133.34		
		91,794.71		
Less: Provision for Depreciation		3,750.00		
				88,044.71
Loans: (Unsecured)	*Good*	*Doubtful*		
Loan Scholarship	Nil	Nil		
Other Loans (to staff)	95.00	Nil		
				95.00
Advances:				
To Trustees	Nil	Nil		
,, Employees (WHO Kerala Trip)	2,400.00	..		
,, Employees (C.S.I.R. Local Trips)	100.00	..		
,, Lawyers	..			
,, Nature Education Scheme	4,285.41	..		
Carried forward	6,785.41	..		
Carried forward ..				1,40,875.34

BALANCE SHEET AS AT 31 *DECEMBER* 1963—(*continued*)

FUNDS AND LIABILITIES		Rs. nP.	Rs. nP.
Brought forward ..			1,28,297.79
Other Earmarked Funds—B/F *Unspent Grant Government of Maharashtra*—(Contd.)		66,745.61	
1963-64 Grant for the year	37,000.00		
1963-64 Additional Grant for the year ..	7,483.00		
	44,483.00		
Less: Spent during the year (as per Income & Expenditure Account) ..	29,879.42		
	14,603.58		
Less: Refund of Amount advanced by the Society for 1962-63 expenditure	471.55	14,132.03	
Unspent Grant World Health Organization			
Balance as per last Balance Sheet	36,365.32		
Less: Utilised during the year	18,604.29	17,761.03	
Carried forward ..		98,638.67	1,28,297.79

ASSETS	Good	Doubtful	Rs. nP.	Rs. nP.
Brought forward ..				1,40,875.34
Advances—(Contd.)				
Brought forward	6,785.41	..		
To Others including Rs.1,388.75 receivable from Sales Tax Dept.	1,437.36	..		
,, Prepaid Expenses	34.00	..		8,256.77
Stocks: (At cost or under)				
Books and Publications ..			24,036.57	
Accumulated cost of Book under Publication (Animal Book 2nd Edition)			18,059.80	42,096.37
Income Outstanding:				
Rent			..	
Interest (Accrued)			1,357.60	
Other Income:				
Supplies and Services ..			18,419.53	
Government of Maharashtra Education Activity Grant 1963-64			4,000.00	
Government of Maharashtra Maintenance Grant				
1962-63 ..	471.55			
1963-64	42,011.45		42,483.00	
Carried forward ..			66,260.13	1,91,228.48

BALANCE SHEET AS AT 31 *DECEMBER* 1963—(*continued*)

FUNDS AND LIABILITIES		Rs. nP.	Rs. nP.
Brought forward ..			1,28,297.79
Other Earmarked Funds—B/F		98,638.67	
Grant Government of India (Unspent) Received during the year 1963-64 (from the Ministry of Education, Department of Science for the Publication of Handbook of Indian Birds)		28,000.00	
Loans (unsecured):			
Loan from Prince of Wales Museum of Western India for the publication of Animal Book, 2nd Edition		25,000.00	
			1,51,638.67
Council of Scientific and Industrial Research Grant:			
1962-63 Grant for the year	2,671.00		
Less: Spent during the year (as per Income and Expenditure Account) ..	1,332.69		
	1,338.31		
Add: 1963-64 Grant for the year	5,381.66		
	6,719.97		
Less: Spent during the year (as per Income and Expenditure Account)	4,311.82		
		2,408.15	
Carried forward ..		2,408.15	2,79,936.46

ASSETS	Rs. nP.	Rs. nP.
Brought forward ..		1,91,228.48
Income Outstanding—B/F	66,260.13	
Other Income (Contd.)		
Government of Maharashtra Furniture Grant 1963-64 ..	2,000.00	
Government of India Grant for Journal Expenses 1963-64 ..	5,000.00	
Government of India Grant for the Publication of Handbook of Indian Birds ..	28,000.00	
		1,01,260.13
Cash and Bank Balances:		
(*a*) In Account with		
National & Grindlays Bank Ltd., Bombay	5,513.78	
National & Grindlays Bank Ltd., London £ 82-3-8	1,095.78	
Chartered Bank, Bombay ..	321.47	
In Fixed Deposit with:		
Chartered Bank, Bombay ..	25,000.00	
(All the above Accounts are in the name of the Bombay Natural History Society)		
(*b*) With the Trustees	..	
(*c*) With the Cashier	650.00	
		32,581.03
Carried forward ..		3,25,069.64

BALANCE SHEET AS AT 31 *DECEMBER* 1963—(*continued*)

FUNDS AND LIABILITIES		Rs. nP.	Rs. nP.	ASSETS	Rs. nP.	Rs. nP.
Brought forward ..			2,79,936.46	Brought forward ..		3,25,069.64
Other Earmarked Funds—B/F		2,408.15		*Income and Expenditure Account*		
Liabilities				Balance as per last Balance Sheet ..	3,968.99	
For Expenses ..	53,680.98			*Add*: Deficit as per Income and Expenditure Account	8,324.25	
,, Advance Subscription..	1,007.20					12,293.24
,, Sundry Credit Balances	330.09					
		55,018.27				
			57,426.42			
Total ..			3,37,362.88	Total ..		3,37,362.88

The above Balance Sheet to the best of our belief contains a true account of the Funds and Liabilities and of the Properties and/Assets of the Trust.

As per our report of even date

(Sd.) A. F. Ferguson & Co.,
Chartered Accountants

(Sd.) J. D. Kapadia,
Trustee

Bombay, 27*th April*, 1964

Registered No. F 244 (BOM)

THE BOMBAY NATURAL HISTORY SOCIETY

THE BOMBAY PUBLIC TRUST ACT 1950

SCHEDULE IX [VIDE RULE 17(1)]

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 DECEMBER 1963

EXPENDITURE	Rs. nP.	Rs. nP.
To Expenses in respect of properties :		
Rates, Taxes, Cesses, Repairs, and Maintenance	nil	nil
Salaries	nil	nil
Insurance	nil	nil
Depreciation (by way of provision or adjustments)	nil	nil
,, *Expenditure from Grants from Government of Maharashtra :*		
For 1962-63 : Salaries	4,330.25	
Rent	5,346.60	
		9,676.85
For 1963-64 : Salaries	13,839.62	
Rent	16,039.80	
		29,879.42
,, *Expenditure from Grants of Council of Scientific and Industrial Research :*		
For 1962-63 : Salaries	1,075.00	
Miscellaneous ..	257.69	
		1,332.69
For 1963-64 : Salaries	3,680.00	
Miscellaneous ..	631.82	
		4,311.82
Carried forward ..		45,200.78

INCOME	Rs. nP.	Rs. nP.
By Rent :		
Accrued	nil	nil
Realised	nil	nil
,, *Interest* (Accrued and Realised) :		
On Securities	3,204.25	
On Bank Account	1,240.85	
		4,445.10
,, *Dividends*		nil
,, *Donations :*		
In cash	nil	nil
In kind	nil	nil
,, *Grants :*		
Government of Maharashtra		
For 1962-63 (Expended as per contra)	9,676.85	
For 1963-64 (Expended as per contra)	29,879.42	
For Educational Activity 1963-64 ..	4,000.00	
Government of India :		
For Journal Expenses for 1963-64 ..	10,000.00	
Carried forward ..	53,556.27	4,445.10

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 DECEMBER 1963—(*continued*)

EXPENDITURE	Rs. nP.	Rs. nP.
Brought forward ..		45,200.78
To Establishment Expenses : ..		
Salaries (Including Dearness Allowance)	34,565.20	
Society's contribution to Staff Provident Fund	2,004.68	
Postages	1,364.08	
Printing and Stationery	1,302.14	
Advertisement	93.50	
Telephone charges	624.28	
Bank charges	204.36	
Electric charges	518.05	
Meeting expenses	382.61	
Motor Car charges account ..	930.91	
Conveyance and Travelling expenses ..	284.05	
		42,273.86
Remuneration to Trustees ..	nil	
Remuneration (In the case of Math)	nil	
Legal Expenses	nil	
Audit Fees	750.00	
Contribution and Fees	nil	
		750.00
,, *Amounts Written off :*		
Bad Debts	nil	
Loan Scholarships	nil	
Irrecoverable Rents	nil	
Other Items	22.67	
		22.67
,, *Miscellaneous Expenses :*		
General Charges	1,415.43	
Fire Insurance	92.70	
Carried forward Rs. ..	1,508.13	88,247.31

INCOME	Rs. nP.	Rs. nP.
Brought forward ..		4,445.10
By Grants—B/F	53,556.27	
Council of Scientific & Industrial Research :		
For 1962-63 (expended as per contra)	1,332.69	
For 1963-64 (—do.—)	4,311.82	
		59,200.78
By Income from Other Sources :		
Subscriptions	22,193.69	
Entrance Fees	505.00	
		22,698.69
,, *Publications :*		
Journal Sales	2,231.95	
,, *Books etc. profits :*		
Book of Indian Birds ..	7,905.14	
Some Beautiful Indian Climbers and Shrubs	870.66	
Some Beautiful Indian Trees ..	647.45	
Butterflies of the Indian Region ..	1,492.90	
Synopsis of Birds of India and Pakistan	610.13	
Game Birds of India Vol. III ..	222.83	
Indian Molluscs	157.50	
Identification of Indian Butterflies by Evans	11.00	
Identification of Poisonous Snakes	6,401.55	
Other Publications	323.52	
Nature Calendars	1,961.22	
Carried forward Rs. ..	22,835.85	86,344.57

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 *DECEMBER* 1963—(*continued*)

EXPENDITURE	Rs. nP.	Rs. nP.	INCOME	Rs. nP.	Rs. nP.
Brought forward ..		88,247.31	Brought forward ..		86,344.57
To Miscellaneous Expenses—B/F ..	1,508.13		*By Books etc. profits*—B/F ..	22,835.85	
Interest on Overdraft Account ..	nil				
Donation to Zoological Society London	66.67				
,, *Depreciation :*		1 ,574.80			
On Investments	nil				
On Furniture	nil	..	*Less* : Packing and Forwarding charges	672.19	22,163.66
,, *Expenditure on Objects of the Trust :*			,, Miscellaneous Receipts ..		3,650.00
(*a*) Religious	nil				
(*b*) Educational—Journal Expenses for the year 1962 ..	5,423.76		,, Profit on Investment matured ..		712.50
—Journal Expenses for the year 1963 ..	23,947.41		,, Refund of Sales Tax for the year 1962 (brought back to Revenue Account)		1,388.75
—*Library Account* (Subscriptions to other Societies) ..	696.11		,, Deficit carried to Balance Sheet ..		8,324.25
—Purchase of Books	344.48				
—Periodical and Binding Charges ..	471.02				
—Maintenance of Reference Collections ..	1,878.84	32,761.62			
Total ..		1,22,583.73	Total ..		1,22,583.73

As per our report of even date

(Sd.) A. F. FERGUSON & CO.,
Chartered Accountants

BOMBAY, 27*th April*, 1964

(Sd.) J. D. KAPADIA,
Trustee

THE BOMBAY NATURAL HISTORY SOCIETY

Statement of Income and Expenditure with respect to the Publication of Journal for the Year Ended 31st December 1963

Receipts	Rs. nP.	Income	Rs. nP.
To Establishment Expenses :		*By Publications :*	
1/3 of Salaries including Dearness Allowance, Society's contribution to Staff Provident Fund, Postages, Printing and Stationery Advertisement, Telephone Charges, Bank Charges, Electric Charges, Meeting Expenses, Motor Car Charges Account, Conveyance & Travelling Expenses ..	14,091.28	Journal Sales	2,231.95
1/3 of Audit Fees	250.00	1/3 of Membership Subscriptions	7,397.90
,, *Miscellaneous Expenses :*		,, *Grants :*	
1/3 of General Charges, Fire Insurance, etc.	524.93	Government of India for publication of Journal 1963-64	10,000.00
1/3 of Library Expenses, Purchase of Books and Periodicals ..	503.87		
1/3 of Maintenance of Reference Collections ..	626.28		
,, Journal Expenses	29,371.17		
Total ..	45,367.53	Total ..	19,629.85

As per our letter of even date

(Sd.) A. F. FERGUSON & CO.,
Chartered Accountants

BOMBAY, 27*th April*, 1964

(Sd.) J. D. KAPADIA,
Trustee

THE BOMBAY NATURAL HISTORY SOCIETY

NATURE EDUCATION SCHEME

Receipts and Payments Account for the year ended 31*st December* 1963

Receipts	Rs. nP.	Rs. nP.
To Balance as at 1st January 1963 Brought forward :		
Cash with Cashier	50.00	
Balance with Bank on Current Account	100.81	
		150.81
,, Grant Government of Maharashtra 1962-63		6,640.00
,, Sales of Booklet No. I	267.45	
,, Sales of Booklet No. II	127.89	
,, Sales of Booklet No. III ..	308.76	
,, Sales of Booklet No. IV ..	215.79	
,, Sales of Booklet No. V ..	277.00	
		1,196.89
,, Sales of Nature Study Pamphlets and Line Drawings		45.94
,, Sales of Science Syllabus Notes ..		170.00
,, Balance carried forward being advance from Bombay Natural History Society		4,285.41
Total ..		12,489.05

Payments		Rs. nP.
By Balance brought forward being advance from Bombay Natural History Society		2,827.47
,, Salaries of Nature Education Organiser ..		5,640.00
,, Postages		180.20
,, Printing and Stationery		243.42
,, Cost of Booklet No. V (in part payment) ..		2,700.00
,, General charges		599.93
,, Balance as at 31st December 1963 :		
Cash with the Cashier	50.00	
With Bank on Current Account ..	248.03	
		298.03
Total ..		12,489.05

Bombay, 27*th April*, 1964

(Sd.) A. F. Ferguson & Co.,
Chartered Accountants

(Sd.) J. D. Kapadia,
Trustee

MINUTES OF THE ANNUAL GENERAL MEETING OF THE BOMBAY NATURAL HISTORY SOCIETY HELD IN THE CONFERENCE HALL OF THE B. E. S. & T. UNDERTAKING, ELECTRIC HOUSE, COLABA, BOMBAY 5, ON TUESDAY, 28TH APRIL 1964, AT 6.30 P.M., WITH DR. SÁLIM ALI, D.SC., F.N.I., IN THE CHAIR

1. The Honorary Secretary's reports for the year ending 31st December 1963 and for the period January to April 1964 having been previously circulated to members were taken as read and adopted.

2. The Balance Sheet and Statement of Accounts presented by the Honorary Secretary in the absence of the Honorary Treasurer were approved.

3. The following were elected as members of the Executive and Advisory Committee for the year 1964-65 :

Executive Committee

President

Mrs. Vijaya Lakshmi Pandit, *Governor of Maharashtra*

Vice-Presidents

Major-General Sir Sahib Singh Sokhey, I.M.S. (Retd.)
Dr. Sálim Ali, D.SC., F.N.I.
Rev. Fr. H. Santapau, S.J.

Hon. Secretary

Mr. Zafar Futehally

Hon. Treasurer

Mr. J. D. Kapadia, I.C.S. (Retd.)

ex-officio

Members

Mr. Humayun Abdulali
Mr. G. V. Bedekar, I.C.S. (Retd.)
Prof. P. V. Bole
Mr. R. E. Hawkins
Dr. C. V. Kulkarni, M.SC., Ph.D.
Mr. D. J. Panday
Dr. T. Ramachandra Rao, D.SC., F.N.I.
Mr. G. S. Ranganathan
Mr. D. E. Reuben, I.C.S. (Retd.)
Y. S. Shivrajkumar of Jasdan

ADVISORY COMMITTEE

Mr. H. G. Acharya, F.R.E.S.	*Ahmedabad*
Mr. F. C. Badhwar, O.B.E.	*New Delhi*
Sir Chintaman Deshmukh, Kt., C.I.E., I.C.S. (Retd.) ..	*New Delhi*
Rev. Fr. Dr. J. B. Freeman, M.A., L.T., Ph.D., D.D. ..	*Mysore*
Mr. E. P. Gee, M.A., C.M.Z.S.	*Shillong*
M. K. Himmatsinhji of Kutch	*Bhuj*
Dr. Baini Prashad, D.Sc., F.N.I.	*Dehra Dun*
Dr. M. L. Roonwal, M.Sc., Ph.D., & Sc.D. (Cantab.), F.N.I., F.Z.S.I.	*Calcutta*
Mr. P. D. Stracey, I.F.S.	*Kohima*
Lt.-Gen. Sir H. Williams, C.B., C.B.E., M.I.C.E., M.I.E.	*New Delhi*

4. The following amendment to the Rules & Regulations of the Society, previously circulated with explanatory notes, was put to the vote and carried unanimously :

For clause 31 of the Rules and Regulations substitute :

'The government and management of the Society shall be vested in a Committee consisting of (1) not more than six *ex officio* members, namely one President, not more than three Vice-Presidents, one Honorary Treasurer, and one Honorary Secretary, (2) ten ordinary members, resident in Bombay or within 200 miles of Bombay, and (3) the Secretary to the Government of India in the Ministry dealing with Scientific Research or his nominee.

'This Committee shall be assisted in an advisory capacity by ten members chosen by the Committee from among members resident in the mofussil more than 200 miles from Bombay. All papers in connection with meetings of the Committee shall as far as possible be sent in advance to the advisory members of the Committee.'

5. A talk was delivered by Mr. Humayun Abdulali on his recent trip to the Andaman and Nicobar islands. The talk was followed by a colour transparency show of photographs taken in the Andamans and Nicobars, which were highly appreciated.

6. The meeting terminated with a vote of thanks to Mr. Humayun Abdulali and to the Chairman of the meeting.

Notes and News

ROWLAND WARD'S 'RECORDS OF BIG GAME', XII EDITION

The twelfth edition of this work is under preparation. It will include the game animals of Europe, Asia, North America, South America, and New Zealand. The text will describe the principal species and subspecies with notes on current problems and considerations relating to the game of each country. Measurements of outstanding trophies of each species will be listed country by country. Photographs of the best trophies and of game in its wild state will illustrate the text.

Those who are interested in having their trophies recorded should apply to the Editor, Mr. Gerald A. Best, 64/65 Grosvenor Street, Mayfair, London W. 1, for measuring instructions, details of minimum measurements, and other information.

* * * *

SYMPOSIUM ON CRUSTACEA—JANUARY 1965

The Marine Biological Association of India proposes to hold a Symposium on Crustacea with the primary aim of reviewing the present position, and discussing the problems and plan for future research.

It is suggested that the Symposium cover the systematics, biology, and fishery of all the extant forms of Crustacea. The venue and the exact dates will be intimated to participants in due course. Those desirous of contributing papers should send the abstracts in duplicate so as to reach the Convener, Symposium, Marine Biological Association of India, Marine Fisheries P.O., Mandapam Camp, S. India, by 15 August 1964, and the full papers on or before 15 November 1964.

* * * *

DEATH OF MR. LOKE WAN THO

As we are going to the press, we have received the sad news of the death in an air crash over Taiwan on 20 June 1964 of Mr. Loke Wan Tho, a Vice-Patron and a generous friend of the Society and an active worker in the ornithological field. A life sketch will be published in our issue for August. We extend our sympathy to his bereaved family.

An Appeal

RESEARCH REQUEST FOR IMMATURE STAGES OF PAPILIONIDAE

A revision of the classification of the family Papilionidae is now in progress. As a major portion of the research is to be based on the immature stages, every effort is being made to obtain these stages of as many species within the family as possible. They should be preserved in Dietrich's Solution: ethyl alcohol (95%) (15 parts); formaldehyde (35-40%) (5 parts); acetic acid (100%) (1 part); glycerine (100%) (2 parts); and water, distilled (100%) (30 parts). I am interested in obtaining series (up to 10 specimens of *each* stage, i.e. ova; 1st, 2nd, 3rd, 4th, 5th larval stages; pupae) of each species. It is very important to my research to have the immature stages of *Bhutanitis lidderdalei* and *Teinopalpus imperialis*. The food plant of *T. imperialis* is thought to be *Daphne nepalensis* or perhaps *D. papyracea* (Chota Aryili, Nepalese). The larva is described as 'green with a large thick head, Papilio-shaped, the tail was certainly aggressive when . . .' touched. The pupa is 'oval greenish with a strange horn . . .' (Lindgren, O., 1920, *J. Bombay Nat. Hist. Soc.* **27** : 177-178). This species is found in Sikkim to Southern Burma, while *B. lidderdalei* is found in Bhutan, Naga and Chin Hills. The larva and pupa of *B. lidderdalei* should be almost black with tubercles and several rows of small yellow or orange spots. The silken 'girdle' may be attached to the point of the head on the pupa. The best and easiest way to find the immatures of any species is to find the female laying eggs; you are certain of your determinations of both the immatures and the food plant. The early stages of *B. lidderdalei* are unknown.

DEPARTMENT OF SCIENCE,
SANTA FE PREPARATORY SCHOOL,
P.O. BOX 335,
SANTA FE, NEW MEXICO,
U.S.A.

KENT H. WILSON,
Chairman

PRINTED AND PUBLISHED BY V. M. PHILIP AT THE DIOCESAN PRESS
10 CHURCH ROAD, VEPERY, MADRAS—25-8-1964. C1322
EDITORS: H. SANTAPAU & ZAFAR FUTEHALLY

THE SOCIETY'S PUBLICATIONS

Mammals

The Book of Indian Animals, by S. H. Prater. 2nd (revised) edition. 28 plates in colour by Paul Barruel and many other illustrations. (*Available shortly*) **Rs. 30**
(*Price to members* **Rs. 25**)

Birds

The Book of Indian Birds, by Sálim Ali. 7th (revised) edition. 64 coloured and many monochrome plates. (*Available shortly*) **Rs. 25**
(*Price to members* Rs. 20)

A Synopsis of the Birds of India and Pakistan, by S. Dillon Ripley II. An up-to-date checklist of all the birds resident and migrant, including those of Nepal, Sikkim, Bhutan, and Ceylon. **Rs. 25**
(*Price to members* Rs. 20)

Snakes

Identification of Poisonous Snakes. Wall chart in English, Gujarati, and Marathi. **Rs. 10**
(*Price to members* Rs. 8)

Miscellaneous

Some Beautiful Indian Trees, by Blatter and Millard. With many coloured and monochrome plates. 2nd edition. Revised by W. T. Stearn **Rs. 20**
(*Price to members* Rs. 16)

Some Beautiful Indian Climbers and Shrubs, by Bor and Raizada. With many coloured and monochrome plates. **Rs. 22**
(*Price to members* Rs. 17.50)

Butterflies of the Indian Region, by M. A. Wynter-Blyth. With 27 coloured and 45 monochrome plates. **Rs. 28**
(*Price to members* Rs. 22.50)

Indian Molluscs, by James Hornell. With 2 coloured and many monochrome plates, and text-figures. **Rs. 6**
(*Price to members* Rs. 4.50)

Glimpses of Nature Series Booklets :

1. OUR BIRDS I (with 8 coloured plates) in Gujarati, Hindi, and Marathi. **Rs. 0.80**
   Kannada **Rs. 0.62**
2. OUR BIRDS II (with 8 coloured plates) in Hindi. **Rs. 0.62**
3. OUR BEAUTIFUL TREES (with 8 coloured plates) in English, Gujarati, Hindi, and Marathi. **Rs. 0.62**
4. OUR MONSOON PLANTS (with 8 coloured plates) in English, Gujarati, Hindi, and Marathi. **Rs. 0.80**
5. OUR ANIMALS (with 8 coloured plates) in English, Gujarati, Hindi, Marathi. **Rs. 1.25**

Back numbers of the Society's Journal. Rates on application.

Correspond with :

The Honorary Secretary,
Bombay Natural History Society,
91, Walkeshwar Road, Bombay 6-WB.

Agents in England :

Messrs. Wheldon & Wesley Ltd.,
Lytton Lodge, Codicote, Nr. Hitchin,
Herts., England.

The Society will gratefully accept back numbers of the *Journal*, particularly numbers prior to Vol. 45, from members who may not wish to preserve them.

TERMS OF MEMBERSHIP

Life Members pay an entrance fee of Rs. 5 and a life membership fee of Rs. 500.
Ordinary Members pay an entrance fee of Rs. 5 and an annual subscription of Rs. 30.

The subscription of members elected in October, November, and December covers the period from the date of their election to the end of the following year.

MEMBERS RESIDING OUTSIDE INDIA

The terms are the same for members living outside India. Such members should pay their subscriptions by means of orders on their Bankers to pay the amount of the subscription, plus postal registration (Rs. 2.50) if required—in all Rs. 32.50—to the Society in Bombay on the 1st January in each year. If this cannot be done, then the sum of £2-10-0 should be paid annually to the Society's London Bankers—The National & Grindlays Bank Ltd., 26 Bishopsgate Street, London, E.C. 2.

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Journal of the Bombay Natural History Society

Vol. 61, No. 2

Editors
H. SANTAPAU, S.J., & ZAFAR FUTEHALLY

AUGUST 1964

Rs. 15

NOTICE TO CONTRIBUTORS

Contributors of scientific articles are requested to assist the editors by observing the following instructions :

1. Papers which have at the same time been offered for publication to other journals or periodicals, or have already been published elsewhere, should not be submitted.

2. The MS. should be typed (double spacing) on one side of a sheet only, and the sheets properly numbered.

3. All scientific names to be printed in italics should be underlined. Both in zoological and in botanical references only the initial letter of the genus is capitalized. The specific and subspecific names always begin with a small letter even if they refer to a person or a place, e.g. *Anthus hodgsoni hodgsoni* or *Streptopelia chinensis suratensis* or *Dimeria blatteri*.

4. Trinomials referring to subspecies should only be used where identification has been authentically established by comparison of specimens actually collected. In all other cases, or where identification is based merely on sight, binomials should be used.

5. Photographs for reproduction must be clear and show good contrast. Prints must be of a size not smaller than 8.20×5.60 cm. (No. 2 Brownie) and on glossy glazed paper.

6. Text-figures, line drawings, and maps should be in Indian ink, preferably on Bristol board.

7. References to literature should be placed at the end of the paper, alphabetically arranged under author's name, with the abridged titles of journals or periodicals underlined (italics) and titles of books *not* underlined (roman type), thus :

Banerji, M. L. (1958): Botanical Exploration in East Nepal. *J. Bombay nat. Hist. Soc.* 55 (2) : 243-268.

Prater, S. H. (1948): The Book of Indian Animals. Bombay.

Titles of papers should not be underlined.

8. Reference to literature in the text should be made by quoting the author's name and year of publication, thus : (Banerji 1958).

9. *Synopsis :* Each scientific paper should be accompanied by a concise, clearly written synopsis, normally not exceeding 200 words.

10. *Reprints :* Authors are supplied 25 reprints of their articles free of charge. In the case of joint authorship, 50 copies will be given gratis to be distributed among the two or more authors. Orders for additional reprints should be in multiples of 25 and should be received within two weeks after the author is informed of the acceptance of the manuscript. They will be charged for at cost plus postage and packing.

EDITORS,
Journal of the Bombay Natural History Society.

91, Walkeshwar Road,
Bombay 6-WB.

VOLUME 61, NO. 2—AUGUST 1964

Date of publication : 23-12-1964

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Reviews :

Miscellaneous Notes :

JOURNAL
OF THE
BOMBAY NATURAL HISTORY SOCIETY

1964 AUGUST | Vol. 61 | No. 2

Notes on the courtship of the land tortoise *Geochelone travancorica* (Boulenger)[1]

BY

WALTER AUFFENBERG

Florida State Museum, Gainesville, Florida, U.S.A.

(*With two plates and a text-figure*)

INTRODUCTION

Geochelone travancorica, a species of land tortoise endemic to south-western India, is very rarely encountered in European and American zoological gardens and museums. Therefore, I was particularly fortunate in obtaining a number of live specimens for studying certain features of both its behaviour and its anatomy. My sincere appreciation is extended to those individuals and institutions who have aided me in obtaining the specimens. In particular I wish to thank the Bombay Natural History Society and Mr. Sane of Sachetan, Bombay.

Though the herpetological literature is sprinkled with observations on the courtship of tortoises (see Loveridge & Williams 1957 for most recent discussion of many Old World species) only a few reports have dealt with the comparative aspects of this behaviour and most publications are based on casual observations of a few tortoises in captivity.

[1] Partially sponsored by National Science Foundation, grant number B 14851.

As part of a broader study of the fossil and Recent land tortoises of the family Testudinidae I have had an opportunity to observe the combat and courtship behaviour of a number of species, and to record these activities on movie film for later comparative analyses. The present report is the first contribution resulting from these studies (Auffenberg MS.), and is based on the behaviour of nine adult males and nine adult females of *G. travancorica* (probably more living specimens of this species than have ever been accumulated in one place before), maintained for a period of up to one year at the time of this writing. All the specimens were taken in Kerala State, India. Some were collected by myself in January 1963, while others were sent to me after my return to the United States.

To date it has been possible to observe only courtship behaviour in this species. Though several sexually active adult males were confined in the same large enclosure for long periods of time no combat was observed.

The courtship pattern

The courtship behaviour of all tortoises can usually be divided into three phases or steps. These are: (1) the behavioural pattern involved in sex and species recognition, (2) the technique whereby the female is 'immobilized' by the male, to allow (3) mounting and intromission. Each of these major steps in the courtship of *Geochelone travancorica* is briefly described below.

1. *Sex and species recognition.* The use of a sequential combination of specific visual and olfactory signals that together provide a means of sex and species recognition in two sympatric South American species of tortoises has been observed (Auffenberg MS.). Only the olfactory signal is found in *Geochelone travancorica.* Apparently there are no visual signals important in courtship. Thus, being based only on an olfactory signal the behavioural pattern involved in sex recognition is very simple. When a sexually active male approaches the posterior portion of the shell of a potential breeding partner the neck is extended and the head moved in a fashion identical to that used in olfactory investigation of food items.

Eglis (1962) has described the olfactory motor patterns of several genera and species of land tortoise, concluding that these patterns are characteristic of particular taxa. His observations suggested that the characteristic olfactory motor pattern in the genus *Geochelone* is one in which the head is moved in a vertical plane, though the precise

nature of the movement is interspecifically variable. However, the present writer has shown (in MS.) that not all species of *Geochelone* possess a vertical pattern, since in at least *G. carbonaria* and *G. denticulata* (not seen by Eglis) it is horizontal.

In *Geochelone travancorica* the olfactory motor pattern is essentially vertical. First the neck is extended in a single, continuous motion, bringing the head near the object to be investigated. The head is then moved through a short vertical arc, frequently followed by a small and rapid curlicue (Plate I, Fig. A). This olfactory behavioural pattern is very similar to that reported for other species of *Geochelone*, as well as the closely related genus *Testudo*.

2. *Immobilization Technique*. Courting males of all species of tortoise observed, either in captivity or in the wild, seem to encounter difficulty in mounting a moving female. This is particularly characteristic of those species which possess a high, vaulted shell, such as *Geochelone elegans*. A correlative morphologic modification in species with a highly-vaulted shell seems to be that the plastron of the male is more concave on its lower surface. Among other things this arrangement increases the stability of an otherwise one-point contact between a sphere and a plane. More specialized modifications in addition to this one seem to allow easier mounting in other kinds of highly-vaulted land turtles. As an example, in the terrestrial North American emydid genus *Terrapene* the hind feet of the males are apparently specially modified so that they can be inserted into the space between the movable rear portion of the plastron and immovable carapace of the female, where they are secured by the female hooking her own legs around them, or closing her shell on them (Evans 1953, Legler 1960, Cohn 1937, *et al.*). This behaviour apparently serves several functions. It assures that intromission remains possible in a species that has the ability to completely close its shell, and is a device whereby the male is kept from falling off the high-vaulted shell of the female. In marine turtles, a single enlarged claw on each flipper of the male grasps the shell of the female, and in kinosternids patches of enlarged scales on the hind legs of the males are apparently used to grasp the females (Carr 1952, *et al.*).

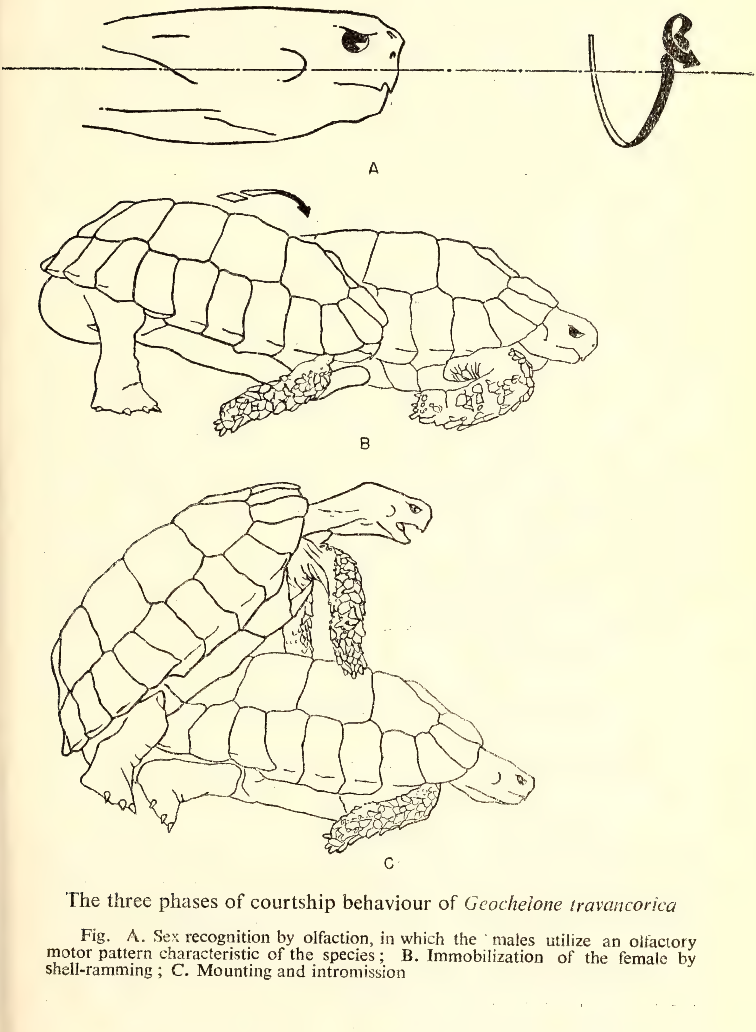
However, in *Geochelone travancorica* there are no apparent anatomical features that assure proper and continuous positioning of the male even though the female walks away, as in *Terrapene*. Thus, immobilization of the female is of considerable importance in this species. In all other turtles in which immobilization plays a role it is usually accomplished by the male either biting the head and legs of

the female so that these parts are kept withdrawn; or by a vigorous ramming of the shell of the female by the male with the anterior projection of his plastron. Somewhat similar tactics by male specimens of the emydid turtle *Terrapene ornata* have been interpreted by Brumwell (1940) as a method of sex recognition. Though sex-recognition is certainly a result of this behavioural pattern, immobilization is probably the primary function. Shell-tapping or ramming (presumably with the same function) is also known in one genus of aquatic turtles (Taylor 1933, for *Kinosternon flavescens flavescens*).

Some species of land tortoises are known to practise only one of these devices—others both. In *Geochelone travancorica* immobilization of the female is accomplished by shell-ramming alone. Leg- or head-biting has never been observed.

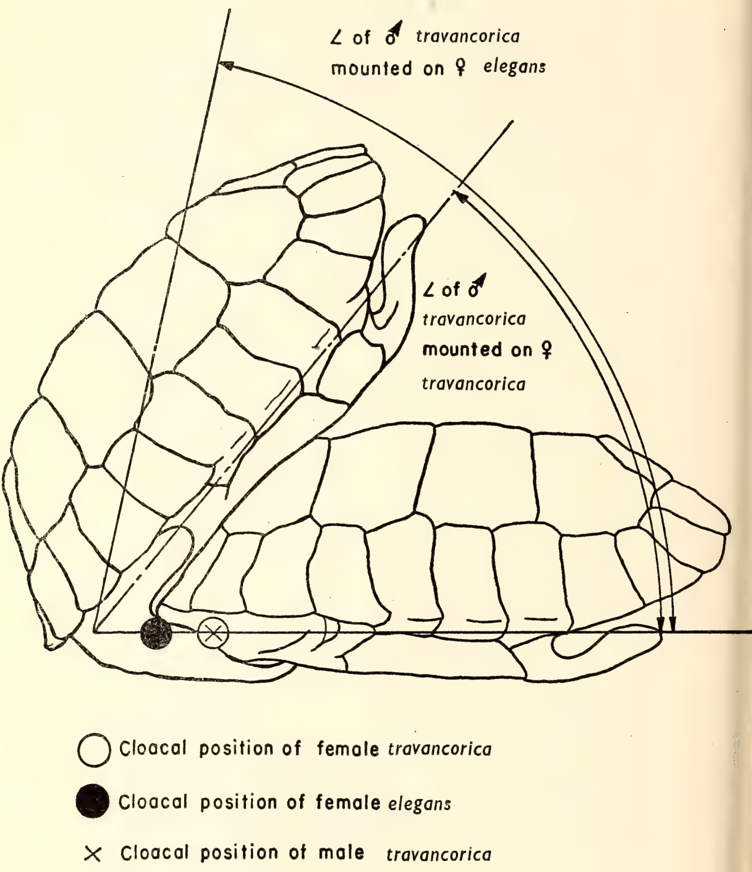
As in other species of tortoises in which shell-ramming is known, the courting male first withdraws the head completely and raises its shell off the ground by extending all four limbs. The anterior limbs are less extended than the posterior members, so that the front of the shell is closer to the ground. Then, after rocking posteriorly, the male quickly lunges forward, sending the gular projection of his plastron crashing against the side or back of the shell of the female (Plate I, Fig. B). The entire cycle normally takes about two seconds, and is repeated a variable number of times, apparently depending upon the effect on the female. When first struck the female invariably withdraws the head and limbs into the shell. However, if she does not remain in that position long, the male continues to pound on her shell until she seems unwilling to walk away. If the female starts to move away, then the mounted male will slide down and again start to ram her shell. This is continued until the female no longer attempts to scramble out from under the male. One captive female was so forcibly and continuously rammed by a large and persistent male that the scutes covering the posterior part of her shell were later sloughed, exposing the carapacial bony elements below.

It is quite possible that shell-ramming is more than a means of immobilizing the female. As pointed out above, it may play a secondary role in sex recognition. It may also be important in hormonal balance and reproductive periodicity. The ramming normally occupies the attention of the adult males for a long period of time before a successful mounting and intromission is actually accomplished. Thus, a male tortoise may attempt to immobilize a female for days, or even weeks, before prolonged mounting is possible. The repeated vigorous ramming of the shell could easily provide an important tactile stimulus whereby the reproductive cycle of the female is ultimately



The three phases of courtship behaviour of *Geochelone travancorica*

Fig. A. Sex recognition by olfaction, in which the males utilize an olfactory motor pattern characteristic of the species; B. Immobilization of the female by shell-ramming; C. Mounting and intromission



Diagrammatic illustration of shell, tail, and cloacal positions of males of *Geochelone travancorica* mounted on females of *G. travancorica* and *G. elegans*

brought into synchrony with that of the male. It has been observed that after prolonged ramming the female seems less inclined to walk away than initially. Thus, successful mating may, at least in the earlier part of the breeding season, depend upon such activity. Similar situations have been described for several other organisms.

That the male courtship behavioural pattern of *Geochelone travancorica* is largely initiated by the scent of the female alone is clearly shown by the fact that when the cloacal exudation of a sexually active female is smeared on a block of wood, box, or any similar object, sexually active males will often ram and mount the object.

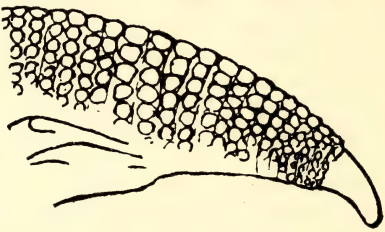
3. *Mounting and intromission.* As pointed out above, successful mounting in most tortoises demands that the female remains passive for a relatively long period of time. This is apparently initially effected by the physical shock of the shell-ramming, and later by the probable effect of constant mating attempts on the reproductive hormonal balance of the female. Proper mounting is also dependent on such mechanical features as shell shape of both pairing members (Plate I, Fig. C).

The shell of *Geochelone travancorica* is not as high-vaulted as that of many other tortoises, such as the sympatric *G. elegans*. Thus, the plastron of *G. travancorica* males is less concave than that of *G. elegans* males. The angle formed by the longitudinal axis of the shell of a male *travancorica* mounted on an immobilized female of the same species is approximately 50 degrees. Due to differences in shell shape this same angle is approximately 80 degrees when a male of *G. travancorica* is mounted on a female of *G. elegans* (Plate II).

The tip of the tail of adult males of *G. travancorica* is provided with a scute-covered hook (Text-fig.). When the tail is held in a normal position the tip of the hook is directed toward the ground. However, when the male is mounted and attempting to breed the tail is directed anteriorly under the shell of the female, and the tip is directed upward against the ventral surface of the plastron. When fully extended and in position for copulation the tip of the hook contacts the femoro-anal suture of the plastron of the female, in which there is frequently a slight depression. This depression receives the tip of the hook, and presumably aids the male in maintaining a mounting posture (Plate II). A similar hook-like structure is apparently employed in the same manner by mounted male kinosternid turtles (Carr 1952, Taylor 1933).

When mounting an adult female of the sympatric species *Geochelone elegans*, the tail of the male of *G. travancorica* is too far forward, and cloacal contact is apparently very rare (Plate II). Furthermore the

male falls off easily, since the tip of the hook extends to a position anterior to the femoro-anal suture, where there is no complementary depression to receive it in the female *G. elegans.*



The tail of an adult male of *G. travancorica*, showing the enlarged terminal hook used in copulation

When mounted, male *Geochelone travancorica* stretch the neck anteriorly, tilting the head slightly downward, and with the mouth widely opened. In this position the male sometimes produces faint grunting noises, considerably less frequent and audible than those produced by mounted males of *G. carbonaria* and *G. denticulata* (Snedigar & Rokosky 1950; Auffenberg MS.)

Discussion

Probably the most important conclusion suggested by the data presently available is that a very simple mechanical mechanism serves to effectively reduce, and probably prohibits, interspecific breeding between the two sympatric species of peninsular Indian tortoises. The factors involved are (1) carapacial contours of the female and plastral contours of the male, and (2) length of the tail of the male, and position of the cloaca in both sexes. Unlike the situation that apparently exists in two closely related South American sympatric species, *Geochelone carbonaria* and *G. denticulata*, there is little or no species discrimination between the two sympatric Indian species, *G. elegans* and *G. travancorica.* Thus, males of *G. travancorica* will attempt to immobilize and mount females of almost any genus of tortoise. This lack of discrimination is believed to be correlated with the presence of an effective mechanical isolating mechanism. A rather simple olfactory cue is apparently used to separate sex, but

not species. The latter is accomplished by non-complementarity of shell shape and cloacal position.

There is, in addition, some ecologic isolation in the two Indian species as well. *Geochelone elegans* tends to inhabit xeric situations, and seems to reach its greatest density in sandy or semi-arid brush lands (personal observation 1963, Deraniyagala 1930, *et al.*). *Geochelone travancorica* tends to inhabit more mesic forest lands.

In south-eastern Asia there are four sympatric species of tortoises (*G. elongata, G. platynota, G. emys,* and *G. impressa*). Of these *Geochelone elongata* is very closely related to *G. travancorica.* The present hiatus in the range between these two species is probably a Late Pleistocene phenomenon. Another south-east Asian species, *Geochelone platynota,* is closely related to *G. elegans.* It would be interesting to know if the ecologic and mechanical isolation mechanisms existing between *G. elongata* and *G. platynota* are similar to those between *G. travancorica* and *G. elegans.* Perhaps more important is that two additional species (*G. emys* and *G. impressa*) found in this same geographic area also possess relatively low shells. Thus shell shape may not be effective in isolating *G. elongata* from these species. Some mechanism other than mechanical isolation must be operative in this situation. Furthermore, the similarity and close relationship of *G. emys* and *G. impressa* suggest the presence of a more sophisticated mechanism that allows effective species discrimination between these two species. This hypothesis must await the future analysis of courtship behaviour in all four of the tortoises of south-eastern Asia.

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Enumeration of Plants from Broach, Gujarat

VEGETATION OF RIVER BED

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Broach is a town on the Western Railway, about 332 km. north of Bombay, on the banks of the River Narbada. The area was visited several times during 1954-57, and again in December 1960, when extensive collections were made and ample field notes taken. In this paper, the vegetation of the river bed is described.

The river bed consists mainly of alluvial soil. Most of the area is utilized for cultivation. *Cajanus cajan* Mill., *Dolichos lablab* L., *Gossypium herbaceum* L., *Nicotiana tabacum* L., *Solanum melongena* L., *Sorghum vulgare* Pers., and *Vigna sinensis* Savi ex Hassk. are commonly cultivated. Occasionally *Capsicum annuum* L., *Coriandrum sativum* L., *Lagenaria leucantha* Rusby, *Lycopersicon esculentum* Mill., *Momordica charantia* L., *Ricinus communis* L., *Trigonella foenum-graecum* L., etc. are cultivated.

Trees are rare, the only ones found are *Azadirachta indica* Juss. and *Pithecellobium dulce* Bth.

In open ground, *Alhagi camelorum* Fisch., *Argemone mexicana* L., *Tamarix ericoides* Rottl., *Xanthium strumarium* L. are very common, often being dominant. *Solanum xanthocarpum* Schrad. & Wendl. and *Volutarella ramosa* (Roxb.) Sant. are also fairly common. *Datura metel* L., *Datura innoxia* Mill., *Lantana indica* Roxb., etc. are occasional. In moist, shaded places, the following are common, scattered or gregarious: *Ammannia baccifera* L., *Bergia ammannioides* Roxb., *Chenopodium album* L., *Cyathocline purpurea* O.K., *Gnaphalium indicum* L., *Gnaphalium luteo-album* L., *Melilotus alba* Lamk., *Rumex dentatus* L., *Sutera glandulosa* Roth., *Veronica anagallis* L., and *Wahlenbergia gracilis* Schrad.; *Gnaphalium pulvinatum* Del., *Grangea maderaspatana* Poir., *Polygonum plebeium* R. Br., *Potentilla supina* L., etc. form dense mats in moist ground.

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A number of weeds were collected from cultivated fields in the river bed. To mention a few, they are *Achyranthes aspera* L., *Boerhavia diffusa* L., *Chrozophora plicata* Juss., *Chrozophora prostrata* Dalz., *Digera muricata* Mart., *Euphorbia dracunculoides* L., *Phyllanthus maderaspatensis* L., *Tribulus terrestris* L., *Trichodesma zeylanicum* R. Br., *Vernonia cinerea* Less., etc.

From the river banks *Azadirachta indica* Juss., *Blumea bifoliata* DC., *Ficus bengalensis* L., *Lindenbergia indica* O.K., *Salvadora persica* L. were collected.

The only parasite noted in the area, *Orobanche cernua* Loefl., is common on *Nicotiana tabacum* L.

In the following list, the names of the plants are commonly those accepted by Cooke in his FLORA ; wherever necessary, names have been changed in accordance with the rules of the INTERNATIONAL CODE OF BOTANICAL NOMENCLATURE ed. 1956.

The author wishes to express his deep sense of gratitude to Rev. Fr. H. Santapau for his unfailing help and encouragement in the work ; also to Dr. N. L. Bor, Kew Gardens, England, for the identification of grasses.

PAPAVERACEAE

1. **Argemone mexicana** L.
Very common and abundant, gregarious, from November to May.

CRUCIFERAE

2. **Brassica nigra** (L.) Koch.
Rare ; an escape.

3. **Lepidium sativum** L.
Only one plant, dried up, in fruit, collected on 18-3-56 ; probably an escape.

POLYGALACEAE

4. **Polygala erioptera** DC.
Occasional. Noted on 25-12-60.

PORTULACACEAE

5. **Portulaca oleracea** L.
Occasional in cultivated fields and in waste ground.

ELATINACEAE

6. **Bergia ammannioides** Roxb.
Very common and abundant, scattered or subgregarious, in moist places.

7. **Bergia odorata** Edgw.
Occasional in open ground. Noted on 25-12-60.

TAMARICACEAE

8. **Tamarix ericoides** Rottl.
Very common and abundant, gregarious.

Malvaceae

9. **Gossypium herbaceum** L.
Common ; cultivated.

10. **Sida acuta** Burm. f.
Occasional in open ground.

11. **Sida spinosa** L.
Common.

12. **Urena lobata** L.
Rare ; in open ground.

Tiliaceae

13. **Corchorus fascicularis** Lamk.
Occasional in moist places.

14. **Corchorus trilocularis** L.
Rare ; noted in fruit on 25-12-60.

Linaceae

15. **Linum usitatissimum** L.
Rare.

Zygophyllaceae

16. **Tribulus terrestris** L.
Common in cultivated fields.

Rhamnaceae

17. **Zizyphus** sp.

Papilionaceae

18. **Alhagi camelorum** Fisch.
Very common and abundant, scattered or gregarious.

19. **Alysicarpus vaginalis** (L.) DC. var. **nummularifolius** (DC.) Baker.
Occasional in cultivated fields.

20. **Alysicarpus** sp.
Rare ; in cultivated fields.

21. **Cicer arietinum** L.
Occasional in cultivated fields.

22. **Crotalaria retusa** L.
Rare.

23. **Dolichos lablab** L.
Extensively cultivated.

24. **Lathyrus sativus** L.
Occasional ; an escape from cultivation.

25. **Medicago sativa** Linn.
Rare ; in moist places. Locally, the plants are used as fodder for horses and are sold in market.

26. **Melilotus alba** Lamk.
Flowers small, white or creamy-yellow. Common in moist, shaded places.

27. **Melilotus indica** All.
Flowers minute, bright yellow or reddish yellow. Only one plant seen in moist ground along with *Melilotus alba* Lamk.

28. **Sesbania bispinosa** (Jacq.) F. & R.
Occasional in moist places.

29. **Trigonella foenum-graecum** L.
Cultivated and as an escape.

30. **Vigna sinensis** (L.) Savi ex Hassk.
Extensively cultivated.

MIMOSACEAE

31. **Acacia arabica** (Lamk.) Willd.
Only one tree.

32. **Mimosa hamata** Willd.
Rare ; in cultivated fields.

33. **Pithecellobium dulce** (Roxb.) Bth.
Only one tree.

ROSACEAE

34. **Potentilla supina** L.
Fairly common in moist places.

LYTHRACEAE

35. **Ammannia baccifera** L.
Very common in moist places, scattered or subgregarious.

36. **Woodfordia fruticosa** (L.) Kurz.
Only one plant seen on walls along river bank on 25-12-60.

ONAGRACEAE

37. **Jussiaea suffruticosa** Linn.
Occasional in moist places, at times gregarious.

CUCURBITACEAE

38. **Citrullus colocynthis** (L.) Schrad.
Common, at times in small patches, in cultivated fields.

39. **Citrullus vulgaris** Schrad.
Rare ; possibly an escape.

40. **Lagenaria leucantha** (Duch.) Rusby.
Cultivated.

41. **Momordica charantia** Linn.
Cultivated.

FICOIDACEAE

42. **Trianthema portulacastrum** L.
Occasional in moist places or in cultivated fields.

Molluginaceae

43. **Glinus lotoides** Linn.
Very common and abundant in drying moist ground.

44. **Glinus oppositifolius** (L.) A. DC.
Very common and abundant in moist ground; also noted on walls along river bank during rainy season.

Umbelliferae

45. **Coriandrum sativum** L.
Cultivated; occasionally an escape.

Compositae

46. **Ageratum conyzoides** L.
Very common, often gregarious, in moist places.

47. **Blainvillea acmella** (L.) Philip.
Only one plant noted in the area, in fruit.

48. **Blumea bifoliata** DC.
Collected from walls along river bank. Rare.

49. **Blumea eriantha** DC.
Occasional in cultivated fields.

50. **Blumea mollis** (Don) Merrill.
Rare; in cultivated fields.

51. **Caesulia axillaris** Roxb.
Occasional in moist places, sometimes gregarious.

52. **Chrysanthemum** sp.
Rare; possibly escaped from cultivation.

53. **Cyathocline purpurea** (Don) O. K.
Common, scattered or gregarious, in moist, shaded places; occasionally in dry, open ground.

54. **Eclipta prostrata** (L.) Linn.
Very common, abundant and often gregarious in the area.

55. **Gnaphalium indicum** L.
Common in drying moist ground.

56. **Gnaphalium luteo-album** Linn.
Common in moist ground, along with the previous species.

57. **Gnaphalium pulvinatum** Del.
Common, forming dense, woolly patches in moist shaded spots.

58. **Grangea maderaspatana** (L.) Poir.
Very common and abundant, forming dense bluish green mats in drying moist ground.

59. **Launaea nudicaulis** (Less.) Hook. f.
Occasional in cultivated fields; also noted on walls along river bank.

60. **Pluchea arguta** Boiss.
Occasional in moist places.

61. **Sphaeranthus indicus** L.
Common.

62. **Vernonia cinerea** Less.
Common in cultivated fields.

63. **Vicoa indica** (Willd.) DC.
Rare ; in cultivated fields.

64. **Volutarella ramosa** (Roxb.) Sant.
Occasional ; on one occasion a large patch was seen in cultivated fields.

65. **Xanthium strumarium** L.
Very common, scattered or gregarious, all over the area.

CAMPANULACEAE

66. **Wahlenbergia gracilis** Schrad.
Common in moist places.

SALVADORACEAE

67. **Salvadora persica** L.
Noted on walls along river bank.

ASCLEPIADACEAE

68. **Cryptostegia grandiflora** (Roxb.) R. Br.

69. **Oxystelma secamone** (L.) Karst.
Rare ; seen only the vegetative shoot.

GENTIANACEAE

70. **Canscora diffusa** R. Br.
Occasional in moist places.

71. **Centaurium roxburghii** (Don) Druce
Rare ; a few plants seen in moist ground.

BORAGINACEAE

72. **Heliotropium supinum** L.
Rare.

73. **Trichodesma zeylanicum** R. Br.
Common, scattered, in cultivated fields.

CONVOLVULACEAE

74. **Cressa cretica** L.
A few plants seen in open ground.

75. **Merremia emarginata** (Burm. f.) Hall.
Rare ; a large patch seen in open dry ground

SOLANACEAE

76. **Capsicum annuum** L.
Cultivated.

77. **Datura metel** L.
Occasional ; in waste land.

78. **Datura innoxia** Mill.
Occasional in cultivated fields.

79. **Lycopersicon esculentum** Mill.
Occasionally cultivated and as an escape.

80. **Nicotiana tabacum** L.
Extensively cultivated.

81. **Solanum melongena** L.
Occasionally cultivated.

82. **Solanum nigrum** L.
Rare.

83. **Solanum xanthocarpum** Schrad. & Wendle.
Very common and abundant in waste land.

Scrophulariaceae

84. **Bacopa monnieri** (L.) Penn.
Rare ; in moist ground.

85. **Lindenbergia indica** (L.) O. K.
Very common on walls along river bank.

86. **Lindernia parviflora** (Roxb.) Haines.
Rare ; in moist ground.

87. **Scoparia dulcis** L.
Rare.

88. **Stemodia viscosa** Roxb.
Common.

89. **Sutera glandulosa** Roth.
Common ; scattered or gregarious, in moist places.

90. **Veronica anagallis** Linn.
Fairly common, scattered or gregarious.

Orobanchaceae

91. **Orobanche cerna** Loefl.
Parasite on the roots of *Nicotiana tabacum* Linn. Common.

Acanthaceae

92. **Asteracantha longifolia** (L.) Nees.
Only one plant seen in open dry soil.

Verbenaceae

93. **Avicennia alba** Bl.
A detached twig was found lying near the water edges ; probably carried away by water currents from marshy places along the shore.

94. **Lantana indica** Roxb.
Common.

95. **Phyla nodiflora** (L.) Green.
Occasional in small, loose patches in moist ground.

LABIATAE

96. **Leucas aspera** (Willd.) Spr.
Common, noted on 25-12-60.

97. **Moschosma polystachyum** Bth.
Only one plant, dried up, in fruit.

98. **Ocimum americanum** L.
Occasional in cultivated fields.

99. **Salvia plebeia** R. Br.
Common, scattered or subgregarious, in moist ground.

NYCTAGINACEAE

100. **Boerhavia diffusa** L.
Occasional in cultivated fields.

AMARANTHACEAE

101. **Achyranthes aspera** L.
Occasional.

102. **Alternanthera sessilis** (L.) R. Br.
Common and gregarious in moist places.

103. **Amaranthus gracilis** Desf.
A common weed in the area.

104. **Amaranthus spinosus** L.
Occasional; in cultivated fields.

105. **Celosia argentea** L.
Occasional.

106. **Digera muricata** (L.) Mart.
Occasional weed in cultivated fields.

107. **Gomphrena celosioides** Mart.
Rare.

108. **Gomphrena globosa** Linn.
Rare; an escape from cultivation, noted on 25-12-60.

109. **Nothosaerva brachiata** (L.) Wt.
Very common, abundant and gregarious, in moist places.

CHENOPODIACEAE

110. **Chenopodium album** L.
Common and abundant in moist places.

POLYGONACEAE

111. **Polygonum glabrum** Willd.
Common and abundant near water courses.

112. **Polygonum plebeium** R. Br.
Very common, forming loose or dense patches, in drying moist ground.

113. **Rumex dentatus** L.
Common.

EUPHORBIACEAE

114. **Chrozophora plicata** Juss.
Common, scattered or subgregarious, in cultivated fields.

115. **Chrozophora prostrata** Dalz.
Common in drying moist ground.

116. **Euphorbia bombaiensis** Sant.
Common ; closely appressed to the ground.

117. **Euphorbia dracunculoides** L.
A common weed in cultivated fields, noted on 25-12-60.

118. **Euphorbia parviflora** L.
Occasional in cultivated fields.

119. **Euphorbia hirta** L.
Common in cultivated fields.

120. **Kirganelia reticulata** (Poir.) Baill.
Common.

121. **Phyllanthus fraternus** Webst.
Occasional in moist places. For the nomenclature of this plant see Webster in *Journ. Arn. Arbor.* **38** : 309, 1957.

122. **Phyllanthus lawii** Grah.
A large patch seen in moist ground, under shade.

123. **Phyllanthus maderaspatensis** L.
Common in cultivated fields.

CYPERACEAE

124. **Cyperus exaltatus** Retz.
Occasional in moist ground.

125. **Cyperus iria** L.
Rare.

126. **Cyperus michelianus** (L.) Link ssp. **pygmaeus** (Rottb.) Asch. & Graebn.
Common.

127. **Cyperus rotundus** L.
Occasional in moist ground.

128. **Fimbristylis dichotoma** Vahl.
Common in moist places and in cultivated fields.

129. **Fimbristylis diphylla** Vahl.
Common.

130. **Scirpus maritimus** L.
Common.

GRAMINEAE

131. **Cynodon dactylon** (L.) Pers.
Very common and abundant.

132. **Dichanthium annulatum** (Forsk.) Stapf.
Common.

133. **Eragrostis diarrhena** (Schult.) Steud.

134. **Eragrostis tenella** (L.) Beauv.
Noted on 25-12-60.

135. **Eleusine coracana** (L.) Gaertn.
Rare.

136. **Eleusine indica** (L.) Gaertn.
Common.

137. **Panicum psilopodium** Trin. var. **coloratum** Hook. f.

138. **Paspalidium geminatum** (Forsk.) Stapf.
Occasional.

139. **Sorghum vulgare** Pers.
Extensively cultivated.

140. **Triticum aestivum** L.
An escape from cultivation ; only two to three plants seen in shade.

On a collection of Fish from the Kameng Frontier Division, N. E. F. A.[1]

BY

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(*With two text-figures*)

INTRODUCTION

The fish collection reported in this paper was made by one of us (K. C. J.) during Feb.-June 1961 in the Kameng Frontier Division, North East Frontier Agency, Assam. A few specimens collected by Shri S. Biswas, Assistant Zoologist of this Department, are also included. The description of a new species of Sisoridae is already published (Jayaram 1964).

This report is the first of fish collection made from this area. Chaudhuri (1913) reported on the fish collections from the Abor country, the present Siang Frontier Division, and described a number of new species besides many interesting new locality records. Besides this there appears to be no other paper regarding the fish fauna of the areas of N.E.F.A.

DESCRIPTION OF KAMENG FRONTIER DIVISION

The Kameng Frontier Division is one of the five divisions of the North East Frontier Agency of Assam. The Kameng Division was known up to 1954 as the Balipara Frontier Tract. Now named after the principal river, the Kameng or the Bhareli, the division is bordered by Bhutan to the west, the Subansiri Frontier Division to the east, Darrang District of Assam to the south, and Tibet to the

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north. In general the country is mountainous, and divided by countless streams. The height of the various ranges is from *c.* 915 to 5488 metres. The forests are thick and crowded at and near the foothills, but become thinner towards the interior. In general they are of mixed monsoon type tending in places to become subtropical to temperate. Evergreen forests are prominent in the Kalaktang-Domko-Membachur-Bomdila route, whereas towards Dirong-Dzong and Kujjalong they are deciduous, with dry aspects rather conspicuous.

The main drainages are: Norgum Chu[1], Dupla Ko[1], Domko Chu, Tenga, Digien or Tammaphu Chu, Kameng or Bhareli River with the minor tributaries Pangabari Chu, Pobrang Chu, Sangti, Chug, and Milankang. Besides these, countless small nullahs and streams, seasonal and perennial, occur: all with swift, cold, clear water flowing over rocks, boulders, and pebbles. Excepting at a few places as in the valleys of Moshing, Shergaon, Siggon, Dirong-Dzong, Naphra, the streams are turbulent and fishing is practised only by means of traps.

METHODS OF TRIBAL FISHING

The tribal people of this division are of various clans: the Monpas, Sherdukpens, Buguns, Akas, Mijis, Bangnis, Daflas, and Sulungs. Though some of them are influenced by Buddhism, all of them are good fishermen, and have devised indigenous traps, nets, lures, and poisons to catch fish. Every tribe and every village has streams over which it claims fishing rights. Fishing besides being a search for food is sometimes a religious activity involving strict taboos. Bones of big fishes (*Labeo* sp., *Oreinus* sp.) are occasionally hung up in some tribal houses. The catch is meticulously divided and distributed according to certain traditional rules. Fishing by outsiders is resented, but once our intention of scientific pursuit was made known they willingly co-operated. In many instances this was achieved by the courteous and appropriate gesture of handing over about half of the catch for their use and consumption.

The tribals do not have any reservations regarding the fish species for their table. Fish dried and fresh are eaten, and some houses have special iron racks above the hearths for drying fish. Drying is adopted because of the large quantity of fish collected rather than by reason of any special liking. Since fishing is often a ceremonial enterprise undertaken by the whole community, a large quantity is netted. Preparation of fish pastes and other fish by-products are not known.

[1] 'Chu' and 'Ko' are tribal words to denote river.

Fishes are generally collected by cast netting the shallow rock pools and rivers where the current is slow, and by means of trapping. The methods adopted are as below:

(*a*) *Organised Community Fishing.* On certain fixed days when fishing is planned, either due to religious ceremony or culinary need of the community, the village headman sends out advance information regarding the time and place of fishing by drum-beat. Almost the entire village folk including women and children turn out at the fishing site. A suitable site is selected on the river, narrow and permitting a diversion to be cut. The diversion, or a *nullah*, should be about 2 to 3 metres wide and sloping so as to allow the water from the main stream to flow through it. It is connected back to the main river 180 to 270 metres down stream, thus not allowing the water to go waste. Dead tree trunks, bushes, and branches are thrown across the main river to serve as anchorage for the dam. Big boulders are also used to serve as supports. At an interval of about 3 metres three vertical poles tied in the form of a tripod stand are erected and anchored to the bed of the river by heavy stone weights. Tarpaulin is stretched across this skeletal support. The upper ends of the tarpaulin are secured to the tripod stands.

The main stream below the dam having thus become partly dry, is now vigorously searched for fish. Leaves and roots of *Maesa indica* Wall., known as a fish poison, are used. The roots are crushed like a brush and inserted beneath big stones and boulders to benumb the fish. Species of *Glyptothorax, Euchiloglanis, Amblyceps, Olyra* were removed by hand from beneath such boulders and rocks. Species of *Oreinus, Noemacheilus, Barilius,* etc. were collected from small rock pools and shallow water pits. The tribals dash the head of the fish on rocks to kill it. The entire stretch from below the dam to the place where the diversion joins the main stream is searched. The whole community joins in collecting the fish. Only fishes are taken and the large number of tadpoles, frogs, trichopteran insects, and insect larvae are discarded. Before leaving the area, the dam and obstructions are removed and the stream returned to its original course. The tribals believe that after such fishing there will be no fish available in that stretch of the river for another fortnight.

(*b*) *Trapping.* This is practised only in small streams and where the flow is fast and torrential. The trap is spindle-shaped in appearance and is made of strong bamboo splinters. The splinters are tied in such a way that the two ends are open and a constriction

is made at the centre. One open end is placed in between the boulders facing the water current. Fishes are caught at the constriction and remain alive because of the stream of water flowing out through the other end. *Pseudecheneis sulcatus* was caught by one such trap.

In some places, instead of the spindle cage remaining open at both ends, the splinters are cut in such a way that they are separate only for about $\frac{3}{4}$ths of the length of the bamboo. The basal portion remains intact and hollow, serving as a receptacle for fish.

(*c*) *Shooting with bow and arrow.* Some tribals use sharpened bamboo splinters as arrows and shoot fish. This is practised only at shallow portions of the river, and where the water is clear. They are fairly accurate shots though the quantity of fish obtained is small. The arrow heads are not poisoned.

Systematic list of the collection

Order CYPRINIFORMES

Division Cyprini

Family cyprinidae

Subfamily (i) rasborinae

1. *Barilius bendelisis* (Hamilton)
2. *Danio aequipinnatus* (McClelland)

Subfamily (ii) cyprininae

3. *Accrossocheilus hexagonolepis* (McClelland)
4. *Labeo dero* (Hamilton)
5. *Labeo dyocheilus* (Hamilton)
6. *Labeo* sp.

Subfamily (iii) garrinae

7. *Garra lamta* (Hamilton)
8. *Garra nasutus* (McClelland)

Subfamily (iv) schizothoracinae

9. *Oreinus plagiostomus plagiostomus* (Heckel)

Subfamily (v) cobitinae

10. *Noemacheilus beavani* Günther
11. *Noemacheilus corica* (Hamilton)
12. *Noemacheilus rupecula rupecula* (McClelland)

Division SILURI

Family AMBLYCEPIDAE

13. *Amblyceps mangois* (Hamilton)

Family OLYRIDAE

14. *Olyra longicaudata* (McClelland)

Family SISORIDAE

15. *Glyptothorax gracilis* (Günther)
16. *Euchiloglanis hodgarti* (Hora)
17. *Euchiloglanis kamengensis* Jayaram
18. *Pseudecheneis sulcatus* (McClelland)

Order PERCIFORMES

Family ANABANTIDAE

19. *Anabas testudineus* (Bloch)

NOTES ON SOME SPECIES

Danio aequipinnatus (McClelland)

1839. *Perilampus aequipinnatus* McClelland in *Asiat. Res.* **19** (2) : 393, t. 60, f. 1 (type-locality, Assam).

1941. *Danio aequipinnatus*, Hora & Nair in *Rec. Indian Mus.* **43** : 371 (notes on synonymy).

MATERIAL

LOT A. 4 examples, 18 mm. to 68 mm. in standard length, Belsiri River, Foothills, 213 m. alt., 27 Feb. 1961.

LOT B. 1 example, 30 mm. in standard length, Norgum River, 3 km. south of Amatulla village, 762 m. alt., 8 Mar. 1961.

LOT C. 50 examples, 12 mm. to 66 mm. in standard length, from a rock pool of Norgum River below Bitselling village, 915 m. alt., 16 May 1961.

LOT D. 4 examples, 44 mm. to 62 mm. in standard length, Norgum River below Ankaling village, 610 m. alt., 17 May 1961.

LOT E. 1 example, 38.5 mm. in standard length, Jhomri Chu at Bairabkunda, 274 m. alt., 20 May 1961.

This species is widely distributed in India, Ceylon, Burma, and Siam. There seems to be no account of the developmental stages of this species giving its juvenile features. We have in our collection a series of 50 examples under Lot C ranging from 16 mm. to 75 mm. in total length which show the growth stages and the variations. These are given below:

Stage 1. 16 *mm. total length.* Eyes large and dark. Lower jaw projecting slightly beyond upper jaw. Dorsal and anal fins fully

differentiated. Pectoral fins partly differentiated. No trace of pelvic fins. Yolk sac not fully absorbed. Chromatophores scattered all over body. A thin black band along centre of body starting only from below dorsal fin insertion; a thick black band over dorsal profile from occiput to dorsal fin base. Lateral line not seen.

Stage 2. 19 *mm. total length.* Eyes small and dark. Lower jaw fitting into upper jaw. All fins well differentiated. Yolk sac completely absorbed. Coloration same as in previous stage. Lateral line not seen.

Stage 3. 25 *mm. total length.* Central black band broader and thicker towards caudal fin, extending from near operculum. A black spot on opercular angle. Black band on dorsal profile from occiput to dorsal fin base faded. Sensory pores on lower jaw seen. Lateral line not seen.

Stage 4. 34 *mm. total length.* Central black band uniformly broad all over. A second lateral black band below the central band extending to anal fin. Occiput black, and band on dorsal profile faded. Opercular spot present. Sensory pores better developed. Lateral line very thinly seen. Branching of dorsal fin rays commences and five branched rays seen.

Stage 5. 39 *mm. total length.* Central black band anteriorly broad and tapering posteriorly; second black lower band extending to anal fin. Pale yellowish ground colour of body in between central and lower black band extending as a broad conspicuous streak. Another pale-yellow streak also seen above central black band. Opercular spot faded. Occiput black. Black band over dorsal profile interrupted. Sensory pores well developed. Lateral line faintly seen.

Stage 6. 45 *mm. total length.* Central dark band darker posteriorly than anteriorly; lower dark band extending to caudal fin base. Intervening lower pale yellowish streak broken above pectoral fin to form a pale yellowish spot. Upper pale yellowish streak slightly faded. Opercular spot conspicuous. Occiput dark. Black streak over dorsal profile continuous to dorsal fin base. Sensory pores well developed. Lateral line clearly seen.

Stage 7. 54 *mm. total length.* Coloration nearly as in previous stage. Bands well formed; three black and white alternating bands. A thin black tinge extends below dorsal fin. Gill membranes forming an inverted U-shaped notch ventrally. Sensory pores well developed. Lateral line clearly seen.

Stage 8. 75 *mm. total length.* Bands completely formed. Central dark band extending to median seven rays of caudal fin. Pale yellow spot above pectoral fin present. Opercular spot diffused. Black

streak over dorsal profile and black colour over occiput both diffused to dull grey of body colour. A black tinge below dorsal fin present. Lateral line clearly seen.

Certain body measurements and counts are given in Table I.

TABLE I

CERTAIN BODY MEASUREMENTS AND COUNTS OF *DANIO AEQUIPINNATUS*

Stage	Total length in mm.	Body depth in mm.	Least depth of caudal peduncle in mm.	Fin Ray Counts			
				A	C	D	
						Br.	Simple
1	16	6	3	11	11	..	5
2	19	4	1.5	13	15	..	7
3	25	6	3	13	19	..	7
4	34	8	4	13	19	5	5
5	39	9	4	14	19	5	5
6	45	11	5	14	20	6	5
7	54	12	6	13	19	7	5
8	75	16.5	8	13	21	10	2

Some authors (Weber & Beaufort 1916; Myers 1952; Hora & Mukerji 1934) have divided the genus *Danio* into two subgenera, *Danio* and *Brachydanio*, based on the number of branched dorsal fin rays. *Brachydanio* is used for species with 7-branched dorsal rays and an incompletely or absent lateral line, whereas *Danio* is used for species with 12- to 16-branched dorsal rays and a complete lateral line. Smith (1945, p. 95) stated that a sharp line of differentiation cannot be drawn between these two subgenera on the basis of these variable characters. The developmental stages described above also indicate that such a division is not justified.

Accrossocheilus hexagonolepis (McClelland)

1839. *Barbus hexagonolepis* McClelland in *Asiat. Res.* **19** : 270, 336, t. 41, f. 3 (type locality, Upper Assam).

1940. *Barbus (Puntius) hexagonolepis*, Hora in *J. Bombay nat. Hist. Soc.* **42** : 81 (systematic position).

MATERIAL

LOT A. 3 examples, 116 to 145 mm. in standard length, Belsiri River, Foothills, 213 m. alt., 27 Feb. 1961.

LOT B. 1 example, 137 mm. in standard length, Norgum River, 1.6 km. below Bokhar village, 254 m. alt., 14 March 1961.

LOT C. 6 examples, 41 to 48 mm. in standard length, from a rock pool of Norgum River below Bitselling village, 915 m. alt., 16 May 1961.

LOT D. 17 examples, 44 to 186 mm. in standard length, Norgum River below Ankaling village, 610 m. alt., 17 May 1961.

The 'Katli' of the Nepalese and 'Bokar' of the Assamese, *A. hexagonolepis* is a widely distributed species and perhaps the commonest large-scaled barbel of Assam and the eastern Himalayas. Formerly placed under the subgenus *Lissochilus* of the genus *Barbus* (*Puntius*), these fishes are characterised by the separation of the lower lip into two lateral parts, exposing the median portion of the lower jaw; the preorbital and suborbital regions have horizontal rows of pores which may be tuberculated. The name *Lissochilus* being preoccupied, Oshima (1919) proposed the name *Accrossocheilus* for these fishes regarding which Smith (1945, p. 197) pointed that the availability of the name 'depends on the acceptance of the view that the various types of lower lip in this group (whether entire, slightly notched, or completely divided with the two halves moderately or widely separated) represent simply intergrading stages of the same structural feature'. Hora (1940, p. 81), while reasoning for keeping these fishes under the separate subgenus *Lissochilus*, stated that these fishes are similar to those of the subgenus *Tor*, in which the condition of the lips is subject to great variation. Usually forms living in shallow torrential streams have hypertrophied lips and those living in clear fast-flowing torrents have thick lips (see Hora 1939 for further details). Hora has shown that the varied pattern of the lips is due to the different habitats in which these fishes may live and that they are only intergrading stages of one basic norm. In the material under study, most of the specimens have an entire lower lip and a few specimens have slightly notched to nearly entire condition. In view of these reasons, we feel that these fishes should be kept under a separate genus *Accrossocheilus* pending a revision of the *Barbus*-group of fishes.

In the material under report the dorsal fin is inserted in advance of the pelvic fin insertion; the pectoral fin in most cases does not extend to the pelvic fin, but in some young examples it reaches the pelvic base. There are two rows of well-formed tubercles on the snout. They extend from below the nostrils to below middle of orbit. In the young specimens the tubercles appear like skin swellings

and later with growth become wart-like and spinous. They occur in a more or less linear arrangement and are found in both sexes.

Labeo sp.

MATERIAL

LOT A. 50 examples, 15 to 23 mm. in standard length, Norgum River, 3 km. south of Amatulla village, 762 m. alt., 8 March 1961.

LOT B. 2 examples, 19 and 25 mm. in standard length, from a rock pool of Norgum River below Bitselling village, 915 m. alt., 16 May 1961.

LOT C. 10 examples, 13.5 to 19 mm. in standard length, from a small stream in Chug River valley, 2134 m. alt., 25 July 1961, S. Biswas coll.

LOT D. 40 examples, 12.5 to 23 mm. in standard length, from the Dupla Ko, 6 km. SW. of Siggon, 1829 m. alt., 29 August 1961, S. Biswas coll.

The specific determination of these specimens is difficult. All of them represent a single species. The main characters are as below:

D. 11 or 12; P. 14 or 15; V. 7 or 8; A. 5; C. 19 to 21

Body compressed; dorsal profile arched. Lips thin and plain. Labial fold interrupted. A thin groove over snout. A pair of minute maxillary barbels. Body covered with numerous irregularly distributed black dots. A black streak along centre of body and a conspicuous dark blotch at caudal base. Scales large, about 23 present. Caudal fin forked and with pointed lobes.

Describing the coloration of *Labeo fimbriatus* (Bloch) Day (1878, p. 536) stated: 'Sometimes a diffused dark blotch at the base of the caudal, and which is almost invariably present in the young'. The distribution of *fimbriatus* extends from Sind, Punjab, NE. Bengal, and Deccan to Orissa. We are unable to identify our material with *fimbriatus* in spite of their similarity in colour pattern, for want of adult specimens. The report of Alikunhi *et al.* (1949) does not deal with the post-larval growth stages of this species nor does Alikunhi (1957, p. 30) mention the presence of any black spots on the caudal fin base.

Garra nasutus (McClelland)

1838. *Platycara nasuta* McClelland in *J. Asiat. Soc. Bengal* **7** (2): 947, t. 4, f. 2, 2*a*, 2*b* (type locality, Kashi Hills).

1921. *Garra nasutus*, Hora in *Rec. Indian Mus.* **22** : 655.

MATERIAL

LOT A. 27 examples, 24 to 40 mm. in standard length, from a rock pool of Norgum River below Bitselling village, 915 m. alt., 16 May 1961.

LOT B. 12 examples, 49 to 79 mm. in standard length, Jhumri Chu near Bhutan border with Bairabkunda, 275 m. alt., 20 May, 1961. (Slightly damaged specimens.)

Hora (1921) gave a description of some young specimens from Manipur and Sikkim. The juvenile specimens under Lot A agree well with Hora's description. The larger specimens under Lot B were picked up from a stream which was drying.

Oreinus plagiostomus plagiostomus (Heckel)

1838. *Schizothorax plagiostomus* Heckel, *Fische aus Cashmir* 16, t. (type locality, Kashmir).

1936. *Oreinus plagiostomus,* Mukerji in *Mem. Conn. Acad.* **10** : 347.

1949. *Oreinus plagiostomus*, Misra in *J. zool. Soc. India* **1** : 39, t. 1, f. 1 & 2.

MATERIAL

LOT A. 45 examples, 33 to 63 mm. in standard length, Belsiri River, Foothills, 213 m. alt., 17 February 1961.

LOT B. 2 examples, 115 and 129 mm. in standard length, Norgum River, 1.6 km. below Bokhar village, 854 m. alt., 14 March 1961.

LOT C. 8 examples, 56 to 101 mm. in standard length, Norgum River, Kalaktang, 1372 m. alt., 22 March 1961.

LOT D. 7 examples (damaged), 51 to 104 mm. in standard length, Dupla Ko, Shergaon, 2012 m. alt., 28 March 1961.

LOT E. 2 examples, 46 and 64 mm. in standard length, Dupla Ko., 1.6 km. south-west of Shergaon, 1829 m. alt., 29 March 1961.

LOT F. 19 examples, 52 to 107 mm. in standard length, from a stream at 6 km. north to Rupa, of the Dikong Ko, 2134 m. alt., 3 April 1961.

LOT G. 33 examples, 31 to 110 mm. in standard length, Dupla Ko, 5 km. north-west of Shergaon, 1829 m. alt., 5 May 1961.

LOT H. 2 examples, 81 and 92 mm. in standard length, Dupla Ko, 5 km. south-west of Shergaon, 2134 m. alt., 6 May 1961.

LOT I. 4 examples, 35 to 47 mm. in standard length, from a rock pool of Norgum River below Bitselling village, 915 m. alt., 16 May 1961.

LOT J. 3 examples, 100 to 126 mm. in standard length, from Dupla Ko at lower Siggon village, 2000 m. alt., 4 May 1961.

LOT K. 2 examples, 85 and 165 mm. in standard length, from a small tributary of Norgum River, 1.6 km. north of Ankaling village, 758 m. alt., 26 May 1961.

LOT L. 4 examples, 51 to 63 mm. in standard length, Dikong Ko, 6 km. north of Rupa, 2134 m. alt., 3 April 1961.

LOT M. 1 example, 78 mm. in standard length, from a small tributary of Chug River, 2134 m. alt., 25 July 1961, S. Biswas coll.

Considerable variation exists in this species. Misra (1949) clarified its specific limits. Mukerji (1936) had differentiated *O. sinuatus* and *O. plagiostomus* by the nature of the dorsal spine, shape of the lower lip, development of the anal scales, and the length of the caudal fin lobes. Misra (1949) stated that there are no valid differences between these two species 'except in the presence in *O. plagiostomus* and absence in *O. sinuatus* of the "pearl organs" and indicated that *O. sinuatus*, so far considered as a separate species, is only the female form of

O. plagiostomus'. Silas (1960) agreeing with Misra synonymized *sinuatus* with *plagiostomus.* The material under report is interesting in respect of these characters. The variations are discussed below:

1. *Dorsal spine.* In general the serrations on the dorsal spine are found only along the lower half of the inner margin and in most specimens they are feeble. Juveniles, however, have a smooth spine. About 31% of the material has the serrations comparatively stronger and these could be referred to as *sinuatus* as per Mukerji's diagnosis.

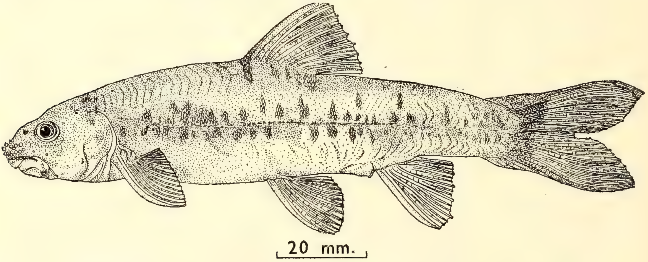
2. *Lower lip.* There is no uniformity in the shape of the lower lip. Only about 19% of the material has the margin of the lower lip somewhat straight. Even amongst those with curved margin of the lower lip, variations from a slightly concave to nearly straight types are seen.

3. *Caudal fin lobes.* Only 101 specimens have undamaged caudal fin. Amongst these the majority have the lobes equal. About 18% only have unequal lobes.

4. *Pearl Organs.* Both sexes have these tubercles. However, only about 76% of individuals which had these tubercles could be referred to Misra's diagnosis of *plagiostomus.*

From the above analysis, it is evident that excepting the nature of the serrations on the dorsal spine, the other characters are not significant to separate *sinuatus* from *plagiostomus.*

The material under Lots J, K, and L perhaps represents the extremes of the range of variability of this species. In all these, the dorsal spine is weak or rudimentary; the outer rays of the pectoral and pelvic fins are covered with thick skin; the dorsal surface of the free



Text-fig. 1. *Oreinus plagiostomus plagiostomus* (Heckel)
Lateral view of a specimen from Lot L, showing the extreme range of variation

portion of the lower lip is beset with many small tubercles as in *Labeo dero*; the scales on the body are sparsely distributed being faintly visible only above the pectoral and near the base of the caudal fin and are apparently absent at other places (Text-fig. 1). The material was thought to represent a hybrid population of *O. plagiostomus* and

Labeo dero, but the extreme variability and the great intergradation of the body features with *plagiostomus* led us to consider it otherwise. Comparison of certain proportions and counts of these specimens with the other material of *plagiostomus* is given in Table II below and the frequency distribution of the fin ray counts in Table III.

TABLE II

COMPARISON OF THE BODY PROPORTIONS AND COUNTS OF TWO LOTS OF *O. PLAGIOSTOMUS PLAGIOSTOMUS*

Characters	Lots A to I N=13		Lots J, K, & L N=9	
	Range	Mean	Range	Mean
Standard length/Head length..	4.11 to 5.00	4.52	4.47 to 5.39	4.83
Standard length/Post-dorsal length ..	1.75 to 1.90	1.79	1.67 to 2.03	1.91
Standard length/Body depth ..	4.58 to 5.40	4.88	4.19 to 5.37	4.58
Standard length/Longest caudal ray ..	3.79 to 4.26	3.99	3.69 to 4.78	4.25
Head length/Eye ..	3.60 to 4.37	4.07	4.00 to 5.07	4.44
Head length/Pect.-Pelvic fin distance ..	0.37 to 0.43	0.41	0.57 to 0.76	0.68
Interorbital width/Eye ..	1.20 to 1.75	1.51	1.54 to 2.15	1.78
Snout/Eye ..	1.50 to 2.00	1.72	1.66 to 2.61	2.13
Dorsal fin rays ..	11	—	9 to 11	—
Pectoral fin rays ..	17	—	16 to 17	—
Pelvic fin rays ..	9	—	9 to 10	—
Lateral line scales ..	98 to 100	—	98 or 99	—

TABLE III

FREQUENCY DISTRIBUTION OF CERTAIN FIN RAY COUNTS IN TWO LOTS OF *O. PLAGIOSTOMUS PLAGIOSTOMUS*

Lots	FIN RAYS (Total branched and simple)										
	Dorsal			Pectoral			Pelvic		Caudal		
	9	10	11	15	16	17	9	10	18	19	20
A to I and M ..	—	29	11	2	3	25	10	30	12	28	—
J, K, and L ..	1	—	8	—	5	4	6	3	—	8	1

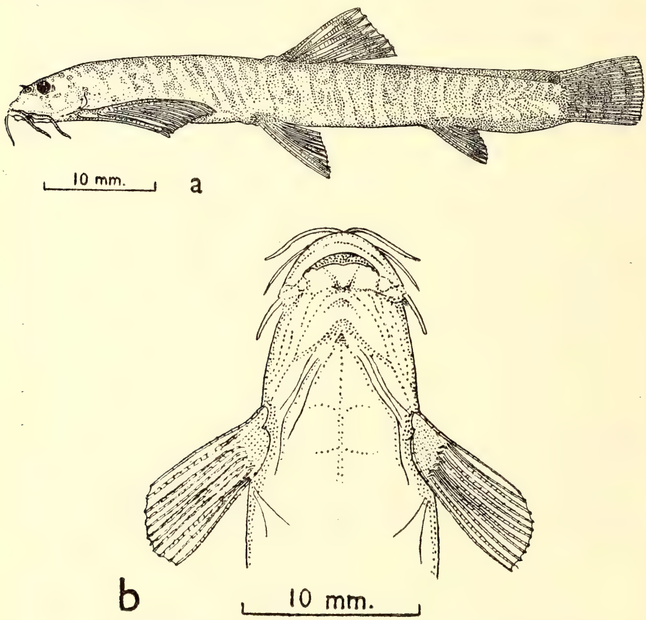
From the comparative tables and analysis some significant differences between the two lots are seen in respect of the position of the eye, and counts of dorsal and pelvic fin rays. However, when statistically analysed the differences are not significant to warrant any taxonomic recognition.

Noemacheilus beavani Günther

1868. *Nemacheilus beavani* Günther, Cat. Fish. Brit. Mus. **7** : 350 (type locality, Kosi River).
1935. *Nemacheilus beavani*, Hora in *Rec. Indian Mus.* **37** : 63, t. 3, f. 11.
1962. *Nemacheilus beavani*, Motwani, Jayaram, & Sehgal, in *Trop. Ecol.* **3** : 23.

MATERIAL

3 examples, 42 to 46 mm. in standard length, from a rock pool of Norgum River, below Bitselling village, 915 m. alt., 16 May 1961.



Text-fig. 2. *Noemacheilus beavani* Günther

a. Lateral view of a specimen showing the diffused bands ; *b*. Ventral view

The three specimens under report, though agreeing with Hora's (1924) description differ in respect of the colour bands. The

characteristic feature of this species is that the vertical bands are broad and fewer in number. Usually about nine dark-grey bands are present with a dark band at the caudal fin base. In our specimens about 12 dark grey bands are seen of which nine towards the posterior are well formed, the anterior three tending to become diffused and slanted. Some of the bands are not fully dark grey, but have vertically oval loop-like areas at the centre through which the basic body colour of olive-yellow is seen. The caudal fin has about three > shaped bands which are not clear in some specimens. There is a dark spot at the top corner of the caudal band, and a dark blotch along the base of the dorsal spine. The specimen illustrated here (Text-fig. 2) represents the extreme form of variation wherein the bands are much diffused.

Noemacheilus corica (Hamilton)

1822. *Cobitis corica* Hamilton, Fish. Ganges : 359, 395 (type locality, Kosi River).

1962. *Noemacheilus corica*, Motwani, Jayaram & Seghal, in *Trop. Ecol.* **3** : 24.

MATERIAL

4 examples, 15.0 to 16.5 mm. in standard length, from a small stream in Chug River valley, 2134 m. alt., 25 July 1961, S. Biswas coll.

N. corica is known from Punjab, NE. Bengal, and Assam. This is the first record of this species from the eastern Himalayas. Though the specimens are juvenile, the diagnostic colour spots, and the elongation of the third and fourth pectoral fin rays are distinctly seen. There are 11 or 12 black blotches along middle of the side and above the pale olive body and also a black spot at the base of the caudal fin.

Noemacheilus rupecula rupecula (McClelland)

1838. *Schistura rupecula* McClelland in *J. Asiat. Soc. Bengal* 7 : 948, t. 55, f. 3 (type locality, Simla).

MATERIAL

One example, 52 mm. in standard length, from the Dupla Ko, 6 km. south-west to Siggon, 1829 m. alt., 29 August 1961, S. Biswas coll.

McClelland described *Schistura rupecula* from 'mountain streams at Simla'. The species was characterised as having about 14 broad

bars on either side, and three across the caudal and dorsal fins; the dorsal fin with eight rays, and the anal fin with seven rays. The illustration accompanying the description indicates clearly 14 vertical colour bands and also the absence of any nasal barbels. The species is widely distributed in the Himalayas.

Günther (1869) referred five specimens from Sikkim to this species and described the coloration as: 'Body with fourteen or fifteen cross bands, broader than the interspaces between them.' He described the nasal appendage as very distinct.

Hora (1935, p. 58) having examined the five specimens of Günther stated that they are identical with hundreds of specimens collected at different places below Darjeeling. Owing to the presence of a distinct nasal barbel in the eastern Himalayan examples, Hora (op. cit.) separated them as a new variety of *N. rupecula* and named it as *inglisi*. However, while discussing the fish fauna of the Naga Hills, Hora & Mukerji (1935, p. 400) referred 21 specimens to *N. rupecula sensu stricto* thereby extending the range of distribution of the species to the eastern Himalayas also. Thus, both forms of *rupecula*, viz. *rupecula s. s.* and *rupecula inglisi* are found in the eastern Himalayas; the latter taxon restricted only to accommodate specimens with a distinct nasal barbel.

The specimen collected from the Dupla Ko agrees with Günther's description except that it has no nasal barbel and is therefore referable to *rupecula rupecula*. The coloration is slightly different. The body is uniformly deep olive with 14 dark grey bands, each broader than the spaces between it and the neighbouring bands. A distinct, but faint, black spot is also present at the base of the dorsal fin. The last band near the caudal fin base is in the form of a large irregular-shaped blotch. The bands on the caudal and dorsal fins are faint. In specimens from the Kumaon Himalayas, the ground colour is pale yellow and the bands are brown in colour, and slightly narrower than in the example under report.

Amblyceps mangois (Hamilton)

1822. *Pimelodus mangois* Hamilton, Fish. Ganges : 199, 379 (type locality, Nathpur, Kosi River).

1933. *Amblyceps mangois*, Hora in *Rec. Indian Mus.* **35** : 617.

MATERIAL

One example, 53 mm. in standard length, from Belsiri River, Foothills, 213 m. alt., 27 Feb. 1961.

The species exhibits a very wide range of variability in regard to the shape of the caudal fin, the length and shape of the adipose dorsal

fin, and the position of the anal papillae. In the specimen under report, the upper lobe of the caudal fin is slightly prolonged; the caudal fin furcate; the adipose dorsal fin free from the caudal fin, long and narrow, and the anal papillae situated nearer the bases of the pelvic fins.

Olyra longicaudata McClelland

1842. *Olyra longicaudata* McClelland in *Calcutta J. nat. Hist.* **2** : 588 (type locality, Khasi Hills, Assam).
1936. *Olyra longicaudata,* Hora in *Rec. Indian Mus.* **38** : 204.

MATERIAL

Two examples, 73 and 91 mm. in standard length, Belsiri River, Foothills, 213 m. alt., 27 Feb. 1961.

The systematic position of this fish was elucidated by Hora (1936). Though six species have been described under *Olyra,* only *longicaudata* is well known from a large number of specimens collected at the base of the Darjeeling Himalayas, Assam, and Tenasserim. All the species are distinguished by the number of anal fin rays. The count given by Hora for *longicaudata* is 23 (loc. cit. p. 204) whereas in the two specimens examined by us, the count is only 16. However, in respect of other features they agree with the description.

Glyptothorax gracile (Günther)

1864. *Glyptosternum gracile* Günther, Cat. Fish. Brit. Mus. **5** : 186 (type locality, Nepal).
1923. *Glyptothorax gracile,* Hora in *Rec. Indian Mus.* **25** : 25.
1954. *Glyptothorax gracile,* Menon in *Rec. Indian Mus.* **52** : 48.

MATERIAL

LOT A. One example, 65 mm. in standard length, Belsiri River, Foothills, 213 m. alt., 27 Feb. 1961.

LOT B. One example, 107 mm. in standard length, Norgum River, 3 km. south to Amatulla village, 762 m. alt., 8 March 1961.

The material under report agrees well with the published description of the species. However, the granulations on the head and the body are not clearly seen in fresh specimens because of the mucous covering. The serrations on the inner margin of the dorsal spine are very feeble. The coloration of the smaller specimen is noteworthy. The dorsal fin and the adipose dorsal fin are tipped black. A diffused large black spot is also present on the caudal fin base. On either side of the body below the dorsal spine a dull white spot is present. The larger specimen on the other hand is uniformly dark-grey.

Acknowledgements

We are indebted to Shri K. C. Johorey, Political Officer, and to Shri A. J. Kundan, Additional Political Officer, at Bomdila who helped one of us (K. C. J.) in various ways. Our thanks are due to Dr. M. L. Roonwal, Director, Zoological Survey of India, for his encouragement and suggestions and to Dr. K. K. Tiwari, Superintending Zoologist, for criticisms.

Summary

This paper lists 19 species of fishes collected from the Kameng Frontier Division, N.E.F.A., and contains taxonomic accounts of eleven of them. The fishing methods practised by the tribals of this area are also discussed. Notes on the systematic position, variations, and geographic distribution of some species are also given.

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Collecting Moths by a mercury vapour lamp in the Surat Dangs

400-watt mercury vapour lamp and west side (inside) wall of the State Transport Bus Depot at Ahwa

Collecting moths by a mercury vapour lamp in the Surat Dangs, Gujarat State

BY

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AND

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(*With a plate*)

During the SW. monsoon, June-October 1961, hundreds of moths (Heterocera) were collected by one of us (EMS) by the light of a 400 watt mercury vapour lamp in the bus depot compound at Ahwa, headquarters of the Dangs District.

The town Ahwa is located in a plateau (alt. 1700 ft.) and is surrounded, at varying distances, mainly by teak trees and bamboo clumps. On dark nights the streets are lit by kerosene lamps which attract a few moths, whereas the powerful mercury vapour lamp located in the State Transport Depot compound attracts many moths and other insects.

The eastern boundary of the bus depot compound consists of a thick stone wall four and a half feet high. Broken glass embedded in concrete on the top of the wall provides numerous hiding places for moths. Near by, four feet from the wall and inside the compound, stands the 25 foot lamp post. The mercury vapour lamp hangs from an angle rod at the top of this post (Plate).

The monsoon season is the best time to collect moths. When the rainfall is heavy at night, the moths shelter on the near-by plants. When the rainfall is light or there is a period between showers, hundreds and even thousands of moths fly around the light. Even when the rainfall is heavy during the day and followed by no rain or by light showers at night, collecting is usually very good. Dry spells invariably meant a reduction in the number of moths appearing at the light. Most

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[1] Present address: 402 Wayne Street, North Manchester, Indiana, U.S.A.

of the collecting was done from 8-00 p.m. to 10-30 p.m., after which time the light was usually turned off.

The length of vision of the insects is yet an unknown factor and, therefore, it is not possible to say from what maximum distances the moths were attracted to the light. The number of insects collected each night, hundreds at times, indicated that they were coming from very long distances. The number collected, more than a thousand during the season, represented only a fraction of the mass assembled at the light.

Previously S. Usman (10, 11, 12) had reported from Bangalore some insect attracted to light. 84 species of moths were included in his list. Very few of those listed by him appear in the present report. Sevastopulo (6, 7, 8, 9) reported about 444 species of moths collected in Calcutta over a period of nearly 17 years in 1930-46. His collection, however, included not only specimens collected at light but also those bred by him in the laboratory, collected from shrubs and trees etc. He was of the opinion that if the mercury light was available in India in those days a very much greater number of moths would have been recorded. Our collection was limited to a four month period, from the middle of June to the middle of October 1961.

The total number of species of moths collected was 180. A few of these which we could not identify were identified for us by the Forest Research Institute, Dehra Dun, to whom we are grateful. A few more were destroyed inadvertently.

Insects belonging to other Orders including some butterflies were attracted to the light and were collected but they are too numerous to be included in this paper. Collection was made with dacron nets and wide-mouthed glass jars. Moths at rest on the perpendicular wall and on low plants were easier to catch with jars. Cotton wool soaked with ether was used as our killing agent.

Collecting at night is sometimes made unpleasant by mosquitoes, blister beetles, and other insects. Also predatory geckos and bats competed for the moths and other insects.

WEATHER

Weather conditions during the period of collection will be of interest. In the following table the weekly rainfall and the average maximum and minimum temperatures recorded at Ahwa by the District Collector's office are shown. That year's rainfall (total 1554 mm.) was much below the average for the place, which averages to 2032 mm. There were very few cloud bursts. This may be one of the causes of such a heavy catch, as heavy downpours cause considerable damage to the exposed larvae and pupae in the soil.

RAINFALL AND TEMPERATURE AT AHWA IN 1961

	Weeks*	Total rainfall in mm.	Average daily temperature max. °C.	Average daily temperature min. °C.
June	1st	4.0	31.6	25.8
	2nd	27.2	28.3	24.3
	3rd	65.7	29.3	25.2
	4th	126.2	26.5	23.0
July	1st	85.4	25.2	22.9
	2nd	203.2	23.3	21.2
	3rd	168.6	23.3	20.7
	4th	88.4	24.8	20.9
August	1st	107.0	22.4	20.0
	2nd	42.0	23.1	20.6
	3rd	86.0	24.3	21.2
	4th	64.0	24.5	21.1
September	1st	120.4	23.0	20.4
	2nd	120.0	23.6	20.9
	3rd	58.0	23.5	20.7
	4th	21.0	23.8	21.3
October	1st	8.0	26.3	21.4
	2nd	153.0	25.3	21.4
	3rd	..	27.2	21.9
	4th	..	27.8	22.1

*1st week : 1-7 ; 2nd week : 8-15 ; 3rd week : 16-22 ; 4th week : 23-end.

SPECIES COLLECTED

In listing the families we have followed the FAUNA OF BRITISH INDIA by Hampson, but within the families the arrangement is alphabetical for convenience of reference. The number of moths collected and the month in which they were caught are also shown in each case. The biggest collection was made in the first half of August and first half of September. Of the total number 40% were Noctuid moths and about 13% belonged

to the family Sphingidae. Notodontidae, Arctiidae, Geometridae, and Pyralidae contributed a fairly large number each to the collection, but the remaining families were represented by very small numbers. However, the number of specimens collected of any species does not give a correct idea of the number attracted to light as the size of the moths affected the size of the catch. Some of the Pyralids, e.g. *Schoenobius* spp., came in very large numbers but only a very few of them were collected whereas proportionately a very large number of Sphingids were easily collected because of their big size.

It is interesting to note that a very large number of species show an extension in the range of their geographical distribution as compared with the FAUNA OF BRITISH INDIA by Hampson (5) — Bell & Scott in the case of Sphingidae (3). Evidently, when these eminent authors wrote their publications the whole of India was not surveyed for insect life. Most of their species, therefore, were noted from the more frequented forest areas, such as south India, Kanara, the Himalayas, Sikkim, Assam, Burma, Ceylon, etc. The rest of India remained practically unexplored except for places like Bombay and surrounding areas where stray cases were noted. More than 40% of the species of the present catch, therefore, can be considered newly recorded in this area, even taking into consideration those species mentioned as occurring in this tract in some agricultural and forestry publications, such as *Reports of the Entomological Meetings at Pusa*, ECOLOGY AND CONTROL OF THE FOREST INSECTS, etc. From this point of view also the present list will prove important. To make clear the present extension, habitats previously noted by other authors are shown against each species.

Lastly, we have to acknowledge with thanks the co-operation extended to us by the Collector of the Dangs in supplying the meteorological data and to Shri S. D. Kale, teacher of the Ahwa School, in collecting the specimens.

MOTHS COLLECTED AT AHWA IN THE DANGS DISTRICT

Serial No.	Family and Species	No. collected	Month of collection	Distribution previously recorded
	Fam. Saturnidae			
1	*Actias selene* Hubn.[1] ..	9	August	All over India
2	*Antheraea paphia* Linn. ..	1	do.	do.

[1] The tails of the beautiful Moon or Fairy Moth (*Actias selene* Hubn.) provide an effective means of defence against insectivorous bats in addition to its speed and dodging ability, and we frequently saw the moth escape to safety while the bat carried away a portion of the tails.

Serial No.	Family and Species	No. collected	Month of collection	Distribution previously recorded
	Fam. Eupterotidae			
3	*Eupterote lineosa* Wlk. ..	1	September	Nepal, Sikkim, Nilgiris, Ceylon
4	*Eupterote minor* Moore ..	1	do.	Does not seem to have been recorded in India
5	*Eupterote mollifera* Wlk. (=*pulchra* Swinh.) ..	1	August	All over India
6	*Eupterote primularis* Moore ..	1	do.	Nilgiris, (southern slopes)
7	*Eupterote undata* Blanch ..	1	do.	Throughout India as far as the Nilgiris
8	*Eupterote* sp. ..	1	do.	..
	Fam. Sphingidae			
9	*Acherontia lachesis* Fabr. ..	3	do.	All over India
10	*Acherontia styx* Westw. ..	1	do.	do.
11	*Ambulyx deucalion* Wlk. ..	1	July	E. and W. Himalayas
12	*Cephonodes hylas* Linn. ..	1	do.	All over India
13	*Deilephila nerii* Linn. ..	1	do.	do.
14	*Herse convolvuli* Linn. ..	3	August	do.
15	*Hippotion boerhaviae* Fabr. ..	9	do.	E. and W. Himalayas
16	*Hippotion celerio* Linn. ..	1	do.	Most parts of India
17	*Hippotion rafflesi* But. ..	8 11	do. September	East Himalayas and South India
18	*Macroglossum belis* Linn. ..	1	July	West Himalayas, South India
19	*Marnmba dyras* Wlk. ..	37 1	August September	NE. Himalayas, South India, Andamans
20	*Meganoton nyctiphanes* Fabr...	1	August	East Himalayas, and South India
21	*Nephele didyma* Fabr. ..	14 7	do. September	All over India
22	*Nephele didyma* f. *hespera* Fabr. ..	23 4	August September	do.
23	*Psilogramma menephron* Cr. ..	10	August	do.

Serial No.	Family and Species	No. collected	Month of collection	Distribution previously recorded
24	*Theretra alecto alecto* Linn. ..	12 32	August September	W. and E. Himalayas, South India, U.P.
25	*Theretra boisduvali* Bugn. ..	4	August	East Himalayas
26	*Theretra castanea* Moore ..	2	do.	South India
27	*Theretra clotho clotho* Drury ..	42 2	do. September	E. and W. Himalayas, South India
28	*Theretra gnoma* Fabr. ..	17	August	S. India, Poona, Pusa, Jeolicote
29	*Theretra lycetus* Cr. ..	56 8	do. September	E. and W. Himalayas, South India
30	*Theretra nessus* Drury ..	20 4	August September	E. and W. Himalayas, South India
31	*Theretra oldenlandiae* Fabr. ..	5 4	August September	E. and W. Himalayas, South India, Darjeeling, Pusa, and Abbotabad
	Fam. Notodontidae			
32	*Antheua servula* Drury ..	2	August	All over India
33	*Anticyra combusta* Wlk. ..	1	July	NW. Himalayas, Karachi, Poona
34	*Cerura liturata* Wlk. ..	2	August	Sikkim, Assam, Bombay, Madras
35	*Dudusa nobilis* Wlk.[1] ..	1	September	Khasis, Bombay, Western Ghats, N. Kanara
36	*Phalera raya* Moore ..	62 4	August September	Sikkim, Nagas, Calcutta, Simla, Bombay
37	*Pheosia strigata* Moore ..	1	June	NE. Bengal, Kanara
38	*Pydna galbana* Swinh. ..	1	September	Sikkim
39	*Pydna longivitta* Wlk. ..	1	June	Simla, Sikkim
40	*Pygaera* sp. ..	1	..	Nagas
41	*Ramesa tosta* Wlk.[2] ..	1	August	..
42	*Spatalia argentifera* Wlk. ..	4	do.	Sikkim, Kanara, Bangalore

[1] Bell (1935, *J. Bombay nat. Hist. Soc.* **38** : 134) states that this species is rare and certainly not attracted to light.

[2] So far recorded from Burma and Ceylon only. However, B.N.H.S. Collection contains specimens from Savantwadi, West Coast.

Serial No.	Family and Species	No. collected	Month of collection	Distribution previously recorded
43	*Stauropus alternus* Wlk. ..	1	August	Sylhet, Bombay, Ganjam, Kanara
	Fam. Zygaenidae			
44	*Phauda limbata* Wllgrn. .. (=*flammans* Wlk.)	1	September	Simla, Sikkim
	Fam. Cossidae			
45	*Duomitus leuconotus* Wlk. ..	1	do.	Simla, Sikkim, Calcutta
	Fam. Thyridiidae			
46	*Rhodoneura hamifera* Moore .. (=*Pyralis acutalis* Wlk.)	1	do.	Nilgiris
47	*Striglina decussata* Moore .. (=*conjuncta* Swinh.)	1	do.	Sikkim, Assam, Nagas
	Fam. Limacodidae			
48	*Altha nivea* Wlk. ..	1	do.	Simla, Kulu, all over India
49	*Miresa decedens* Wlk. ..	1 1	August September	Assam, Nilgiris
50	*Miresa nivaha* Moore ..	1	August	Kanara
51	*Parasa bicolor* Wlk. ..	1	September	All over India
52	*Parasa hilaris* Westw. ..	1	do.	do.
53	*Parasa retracta* Wlk.[1] ..	1 1	July September	..
	Fam. Lasiocampidae			
54	*Metanastria aconyta* Cr. ..	1	do.	Sikkim, Kanara
55	*Odonestis laeta* Wlk. ..	1	do.	NW. Himalayas, Sikkim, Sylhet
56	*Taragama* sp. ..	1	do.	..
	Fam. Lymantriidae			
57	*Euproctis bipunctapex* Hamps...	1	..	Kangra, Nagas, Nilgiris
58	*Euproctis fraterna* Moore ..	1 2	August September	All over India

[1] No record of the locality is available in published literature. B.N.H.S. Collection is from Bombay, Belgaum, Khandesh, and Kanara by R. D. Bell.

Serial No.	Family and Species	No. collected	Month of collection	Distribution previously recorded
59	*Euproctis* sp. ..	1	September	..
60	*Laelia* sp. ..	1	August	..
61	*Lymantria rosea* Hamps. ..	1 1 1	July August September	Marapharita near Sadiya, Assam
62	*Lymantria viola* Swinh. ..	1	do.	Bombay
	Fam. Hypsidae			
63	*Digama hearsayana* Moore ..	1	do.	All over India
	Fam. Arctiidae			
64	*Amsacta lineola* Fabr. .. (= *Creatonotus emittens* Wlk.)	18 2	August September	NW. Himalayas, Nepal, Manipur, South India
65	*Callimorpha* sp. ..	2	August	..
66	*Creatonotus lactinea* Cr. .. (= *Rhodogastrea frederici* Kirby)	3	September	All over India
67	*Cyana peregrina* Wlk. ..	1	do.	do.
68	*Diacrisia obliqua* Wlk. (= *Spilosoma todarum* Moore)	2 1	August September	do.
69	*Estigmene perrotteti* Guen. .. (= *Alphaea biguttata* Wlk.)	2 8 11	July August September	Sikkim, Pareshnath, Kanara, Nilgiris (western slopes)
70	*Estigmene nigricans* Moore .. (= *Alphaea nigricans* Moore)	2 2 1	July August September	Deccan, Bombay, Matheran
71	*Macrobrochis gigas* Wlk. ..	1	July	Sikkim, Bhutan, Assam
72	*Nepita conferta* Wlk. ..	1	September	All over India
73	*Nola major* Hamps. ..	3	do.	Nilgiris (western slopes, 3000 ft.)
74	*Pericallia* (*Arctia*) *ricini* Fabr...	1	August	All over India
75	*Philagria entella* Cr. ..	4 3	do. September	South India
76	*Spilosoma* (*Thyrgorina*) *eximea* Swinh.	1 3	July September	Kanara

Serial No.	Family and Species.	No. collected	Month of collection	Distribution previously recorded
	Fam. Agaristidae			
77	*Aegocera bimaculata* Wlk. ..	1 2	June July	Plains of India, Sikkim
78	*Aegocera tripartita* Kirby[1] ..	1	June	..
79	*Aegocera venulia* Cr. ..	1	August	Sub-Himalayan tracts of Kashmir and Sikkim, and plains of India
80	*Eusemia adulatrix* Koll. ..	1	September	All over India
	Fam. Noctuidae			
81	*Acantholipes* sp. ..	1	do.	..
82	*Acontia intersepta* Guen. ..	1	do.	All over India
83	*Acontia transversa* Guen. ..	1	July	do.
84	*Agrótis flammatra* Fabr. ..	1 2	do. September	NW. Himalayas, Punjab, Sikkim, and *vide* Fletcher (4) Pusa in its southernmost limit
85	*Anomis fulvida* Guen. ..	1	do.	All over India
86	*Anomis mesogona* Wlk. ..	1	do.	do.
87	*Calesia dasyptera* Koll. ..	1	do.	do.
88	*Calesia phaeosoma* Hamps. ..	1	do.	Nilgiris
89	*Calesia satellitia* Moore ..	3 5 1	July August September	W. and S. India
90	*Calpe emarginata* Fabr. ..	1	August	All over India
91	*Calpe minuticornis* Guen. ..	1	September	do.
92	*Catephia lineola* Guen. ..	1	August	do.
93	*Cetola dentata* Wlk. ..	1	October	Nepal, Mhow
94	*Chrysopera combinans* Wlk. ..	1	June	NW. Himalayas, and peninsular India
95	*Churia arcuata* Wlk. .. (= *Churia iconica* Wlk.)	12	September	Sikkim, Khasis, Khandesh, Nilgiris

[1] Not recorded in India so far. However, B. N. H. S. Collection contains specimens from Tanna (= Thana).

Serial No.	Family and Species	No. collected	Month of collection	Distribution previously recorded
96	*Cirphis* sp.[1] ..	1	September	..
97	*Cirphis* sp.[1] ..	1	do.	..
98	*Cosmophila erosa* Hubn. ..	1	do.	All over India
99	*Egnasia accingalis* Wlk. ..	1	August	India
100	*Episparis varialis* Wlk. ..	1 3	July August	All over India
101	*Erastroides curvifascia* Hamps.	1	do.	Ganjam and Nilgiris
102	*Ercheia cyllaria* Cr. ..	1	do.	All over India
103	*Erygia apicalis* Guen. ..	1	September	do.
104	*Eutelia nugatrix* Guen. ..	1	do.	do.
105	*Fodina stola* Guen. ..	1	July	NW. Himalayas, Sikkim, Bhutan
106	*Grammodes geometrica* Fabr. ..	4	September	All over India
107	*Hamodes aurantiaca* Guen. ..	1	August	W. India, Sikkim, Assam, Andamans
108	*Heliothis obsoleta* Fabr. ..	1 2	July September	All over India
109	*Hyblaea puera* Cram.[2] ..	1	July	do.
110	*Hylodes caranea* Cram. ..	1	September	do.
111	*Hypocala biarcuata* Wlk. ..	1	August	Kanara, Tenasserim
112	*Hypocala rostrata* Fabr. ..	1	September	NW. Himalayas, Kanara, Nilgiris
113	*Leucanea irregularis* Wlk.[3] ..	1	July	..
114	*Leucanea* sp. ..	1	September	..
115	*Masalia* (=*Timora*) *terracotta* Hamps. = *Chariclea beatrix* Moore)	6	do.	Baluchistan Mhow, NW. Himalayas
116	*Nyctipao hieroglyphica* Drury ..	1	August	Kanara, Nilgiris, and all over India
117	*Nyctipao macrops* Linn. ..	1	do.	All over India
118	*Ophideris ancilla* Cram. ..	1	September	do.

[1] These two specimens belong to two different species of *Cirphis* but could not be specifically identified.

[2] Thousands resting on teak trees in July and August.

[3] Not recorded in India so far. However, B.N.H.S. Collection contains specimens from Ceylon.

Serial No.	Family and Species	No. collected	Month of collection	Distribution previously recorded
119	*Ophideris fullonica* Linn. ..	1	September	All over India
120	*Ophideris materna* Linn. ..	1	do.	do.
121	*Ophiusa algira* Linn. .	1 6	July August	do.
122	*Ophiusa coronata* Fabr. ..	2	do.	do.
123	*Ophiusa crameri* Moore ..	3	do.	All over India
124	*Ophiusa dotata* Fabr. ..	1	do.	do.
125	*Ophiusa joviana* Cram. ..	1	September	do.
126	*Ophiusa melicerta* Drury ..	5 1	August September	do.
127	*Pandesma anysa* Guen. ..	6 12	August September	do.
128	*Pericyma umbrina* Guen. ..	1	do.	India and Burma
129	*Plecoptera reflexa* Guen. ..	3 2	August September	All over India
130	*Plusia eriosoma* Doub. ..	2 7	August September	do
131	*Plusia jessica* But. ..	1 5	August September	NW. Himalayas
132	*Plusio ni* Hubn. ..	4 1	August September	All over India
133	*Plusia signata* Fabr. ..	1	do.	Bihar, S. India
134	*Polydesma inangulata* Guen. ..	8	do.	All over India
135	*Polytela gloriosa* Fabr. ..	1	do.	do.
136	*Prodenia litura* Boisd. ..	3	August	do.
137	*Pseudelydna rufoflava* Wlk. ..	1	do.	Almora
138	*Psimada quadripennis* Wlk. ..	1 1	do. September	Kanara, Andamans
139	*Remigia archesia* Cram. ..	1	do.	All over India
140	*Remigia frugalis* Fabr. ..	1	do.	do.
141	*Rhesala imperata* Wlk. ..	1	August	Andamans
142	*Sesamia inferens* Wlk. ..	3	September	Sind, Bombay Mhow, Surat, Navsari
143	*Spirama retorta* Cram. ..	5 4	August September	All over India

Serial No.	Family and Species	No. collected	Month of collection	Distribution previously recorded
144	*Spirama unistrigata* Guen. ..	2	August	Sikkim, Assam
145	*Spirama vespertilio* Fabr. ..	6 2	do. September	All over India
146	*Spodoptera mauritia* Boisd. ..	1 2	August September	do.
147	*Thermesia rubricans* Boisd. ..	2	do.	do.
148	*Trigonodes hyppasia* Cram. ..	1	do.	do.
149	*Westermannia superba* Hubn. ..	1 5	August September	W. and S. India
150	*Zalissa transiens* Wlk. ..	1	do.	Sikkim, Khasis, Nagas
151	*Zalissa venosa* Moore ..	1 1	June August	Sikkim
	Fam. Uranidae			
152	*Pseudomicronia coelata* Moore	1	do.	Sikkim, Khasis, Nilgiris
	Fam. Epiplemidae			
153	*Dirades theclata* Guen. ..	2	do.	All over India
154	*Epiplema quadricaudata* Wlk.	1	September	Assam, Kanara, Andamans
	Fam. Geometridae			
155	*Aplochlora vivilaca* Wlk. ..	1	August	Sikkim, Bombay, Khandala
156	*Biston raptaria* Wlk. ..	1 1	do. September	Nilgiris
157	*Biston suppressaria* Guen. ..	9	August	Kangra, Sikkim, Assam, Calcutta, and South India
158	*Biston varianaria* Swinh. ..	34 13	do. September	Mhow, Poona, N. Kanara
159	*Ctenognophos* sp. ..	1	do.	..
160	*Hyposidra talaca* Wlk. ..	4 3 1	July August September	All over India
161	*Macaria fasciata* Fabr. ..	1	July	do.
162	*Phibalapteryx hypospilata* Guen.	1 3	August September	Khasis, Mahableshwar, Nilgiris, Anamalais

Serial No.	Family and Species	No. collected	Month of collection	Distribution previously recorded
163	*Platycerota punctilineata* Hamps.[1]	1	August	..
164	*Semiothisa eleonora* Cr. .. (=*Macaria fasciata* Fabr.)	1 1	July October	All over India
165	*Thalassodes quadraria* Guen. ..	1	September	do.
	Fam. Pyralidae			
166	*Agathodes ostentalis* Hubn. ..	1 1	August September	do.
167	*Botyodes asialis* Guen. ..	1	do.	do.
168	*Charltona* sp. ..	1	August	..
169	*Glyphodes vertumnalis* Guen. ..	1 17	July August	All over India
170	*Maruca amboinalis* Feld. ..	1	do.	Sikkim, Khasis, Nilgiris
171	*Nymphula depunctalis* Guen. ..	1	do.	All over India
172	*Pachyzancla phaeopteralis* Guen.	1	September	do.
173	*Pachyzancla* sp. ..	18 2	August September	..
174	*Pygospila tyres* Cr. ..	1 10 2	July August September	All over India
175	*Schoenobius bipunctifer* Wlk.[2]	1	do.	do.
176	*Schoenobius incertellus* Wlk.[2] ..	2	do.	Nagas, Calcutta, S. India
177	*Sylepta adductalis* Wlk. ..	1	do.	Nilgiris
178	*Sylepta aurantiacalis* Fisch. ..	1	do.	All over India
179	*Sylepta concatenalis* Wlk. ..	1	do.	Sikkim
180	*Sylepta derogata* Fabr. ..	1	do.	All over India

[1] Not recorded in India so far. However, B.N.H.S. Collection contains specimens from Karwar, N. Kanara.

[2] These moths were attracted to light in very large numbers, but only a few were caught.

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Observations on the breeding habits of the Bronzewinged Jaçana [*Metopidius indicus* (Latham)]

BY

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INTRODUCTION

It is recorded that among Jaçanas the role of the sexes is reversed to a great extent. Miller (1925) found this in the Mexican Jaçana [*Jaçana spinosa* (Linné)] and Hoffmann (1949) in the Pheasant-tailed Jaçana [*Hydrophasianus chirurgus* (Scopoli)]. In the latter the female is larger in size than the male and is polyandrous, and the male carries out most (or all) of the incubation and care of young. In the Bronzewinged Jaçana [*Metopidius indicus* (Latham)] also the female is slightly larger than the male and the pattern of breeding is similar to that of the Pheasant-tailed Jaçana.

FIELD NOTES

From 23 July to 9 October 1963 I had the opportunity to observe the breeding habits of the Bronzewinged Jaçana at a freshwater tank situated at the Powai Unit of Aarey Milk Colony in Salsette Island, Bombay. Observations were made with a pair of 8×30 binoculars. Duration of observations was over two hours on alternate days, and extended to seven hours on holidays.

The tank is a natural body of water more or less oblong in shape and approximately 4500 sq. metres in area. It is overhung by gulmohur and mango trees and its vegetation has been altered by man. Introduced para grass is the dominant plant on the nesting sites. Waterlily (*Nymphaea pubescens*) and a floating species of *Ipomoea* also occur.

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The observations were on three adult birds (two males and one female) which bred at the tank. The female was distinguished by its slightly larger size and the second male (B) by a gap in its right wing caused by the loss of a number of primaries. These three birds did not tolerate any other Bronzewinged Jaçana on the tank, and I could distinguish them at every stage even though the birds were not individually marked.

When I started watching on July 23 the female had already paired with the male with undamaged wing (male A) and a clutch of 4 eggs had been completed. No courtship was observed between the pair. The nest was built on an isolated patch of floating grass about a foot square in area. The grass provided good camouflage to the brooding bird, male A.

July 23-27 (3 observations):

During this period, only this couple was on the tank. Male A incubated consistently, leaving the nest only for feeding. The female vigorously defended the territory, chasing away waterhens and pond herons. The pair would exchange contact notes. Once when turtles moved near the nest (there were about six turtles resident in the tank) the female stood guard near the nest.

The male was always on the nest when observations were completed for the day at 18 to 19.30 hours, and apparently spent the night on the nest while the female roosted some six feet away in floating grass.

July 29 to August 13 (10 observations):

The second male Bronzewinged Jaçana (B) started visiting the tank. Male A left his eggs and chased the intruder and pecked him furiously, time and time again. The female appeared to be indifferent to the new arrival. Male B established a territory in the southern half of the tank in spite of A's 'threat-postures' against him. By August 3, the two males appeared to have demarcated their territories by an imaginary line running east and west and roughly bisecting the tank. I marked this boundary visually by a Gulmohur tree on the eastern margin of the tank. If one male went about two yards beyond this border the other would fight him. Male A continued to incubate consistently, never leaving the nest for a period longer than 30 minutes. I never saw the female incubating or taking any interest in the chicks which appeared on August 13, 20 days after commencement of observation. Male A looked after the chicks.

On August 3, the males fought each other 4-5 times during the 6

hours of observation and were pecked by the female till they stopped fighting.

The female also chased the males after the fight. On this day B was seen collecting nest-material and for the first time the female was seen soliciting him. Covering did not take place, but it was certain that the female had accepted B as a breeding partner. By the middle of September this pair produced three clutches of eggs.

Clutch 1. *August* 3 *to* 19. (7 *observations*):

Male B and the female collected bits of grass and *Ipomoea* from almost everywhere in the southern half of the tank (B's territory), but very little of the material was used for the nest. Their first nest was a poorly-concealed waterlily leaf with a few grass blades thrown here and there. The female solicited on seven occasions and was covered by B. Between August 13 and 19, three eggs were laid and B started incubating. Unlike A he did not brood very consistently and the eggs disappeared on August 21.

Clutch 2. *August* 21 *to September* 1. (6 *observations*):

The female and B working jointly built another nest about 6 feet away from their first. Between these dates I observed four instances of coition, each after the female had solicited. On August 28 two eggs were observed with B brooding inconsistently. He was also seen covering the female whenever she presented. Male B and the female would sometimes leave the tank for about an hour, 2 to 3 times a day, possibly for the purpose of feeding. It was noted that the female would be the first to leave the tank on such trips and would be away from the tank for a longer period than the male. The nest was as crudely constructed and as poorly concealed as the one before, and suffered a similar fate. By September the second clutch of eggs disappeared.

Clutch 3. *September* 2 *to* 26. (10 *observations*):

On September 2 the pair (B and the female) was building again, this time in a thick patch of para grass in the southern margin. Material was gathered very inconsistently and from all over the territory. Between September 2 and 7 the female solicited eight times while I was observing and was covered. B incubated from September 10 to 24 but lost his clutch of eggs after this date. After September 14 the female was not seen at the tank. B continued to defend his territory till the end of September. After September 30 he left the tank.

With the disappearance of his neighbour, Male A (who had been looking after his three chicks) occupied the entire tank and, when last observed, he was feeding with three chicks in the former territory of Male B.

General Observations

Territory:

Each male Bronzewinged Jaçana had a territory of over 2000 sq. metres (approx.) which he defended vigorously from every bird other than his female partner. One male would not let his neighbour into his territory but would try to use his neighbour's territory whenever the owner was temporarily away. The female defended the territories of the two males and could feed anywhere.

Defensive displays:

Whenever one male entered the territory of his neighbour, or when a male found that his neighbour was likely to trespass, the owner moved to the threatened border and struck threat postures, standing with stretched neck and, often, open wings. Each male moved in a zigzag manner and repeated the display. If the intruder did not withdraw, there ensued furious pecking. Whenever the female was near by she pecked them apart. The fighting birds sometimes went under water and, till the birds emerged, a soggy mess of intertwined wings popped up from time to time. Such a fight occupied 2 to 5 minutes. When the fighting males emerged the female chased and pecked them. In 98 hours of observations the males made 102 defensive displays against one another, and 12 of these ended in fights.

The female defended the territories of the two males from birds of other species like pond herons, whitebreasted waterhens, and lesser whistling teals. When predatory birds approached, the female produced a wheezy piping call and agitatedly flew about, but no instance of attacking was seen. The female stood guard near the nest for periods up to half an hour whenever turtles passed near it. Throughout the period of observation the female defended the whole area of the tank, irrespective of the territories of the males.

Injury simulation:

Male B, whenever he was pecked by the female following a fight with A, let his wings sag and produced the whistling call creating the impression (on the observer) that he was injured.

Courtship activities:

The female periodically attained peaks of sexual excitement. She postured before the male. Her body became rigid and she stood absolutely still with her vent raised towards the male. The male responded to this display by covering her. I have observed only two instances (out of 19) when the male did not respond to soliciting. The female postured for a minute and resumed feeding. Such a display by the female and the consequent covering occupied a space of two minutes, out of which 30 to 45 seconds were used for coition. I have observed coition between 1.30 p.m. and 7 p.m. only, except on a solitary occasion. All were prompted by the hen.

Nest building:

Both sexes shared building and also did a lot of purposeless collecting of material. Out of the four nests seen this season one was on a patch of grass (above some 8 ft. depth of water) just about 3 to 4 inches above water-level. Two were built on waterlily leaves above 12 to 15 ft. depth of water. The fourth was in a thick patch of grass but barely out of water.

Displacement activities ? :

The Bronzewinged Jaçanas indulged in some incongruous activities. Are these displacement acts? (1) When a brooding male was disturbed by an intruder, he leaped 3 to 4 feet into the air calling agitatedly. This act was repeated several times and apparently called attention to the nest rather than away from it. (2) Immediately after coition the female pulled out nesting material for a few minutes; such material was rarely used for the nests.

Call notes:

Sálim Ali (1961) has distinguished two types of calls, 'a short harsh grunt; also a wheezy piping *seek-seek-seek* etc. Both sexes used these calls in the same contexts, but the female's voice had more depth. The grunt was used as a contact note by the breeding pairs, and also when a bird left the tank or returned to it. The second, asthmatic call was often produced when the birds were disturbed by intruders or were fighting one another.

Incubation:

The pattern of incubation of the two males was different. Male A used 54.3% of the time (in 30 hours of observation) for incubation, 16.9% for feeding, and the rest for preening, defending, etc. Male B

incubated only 15.7% (of 34½ hours of observation), and used 24.8% for feeding, and the rest for other activities. On an average, incubating males left their nests 3.5 times per hour.

Parental care:

The chicks were looked after entirely by the male. He conducted them for feeding in his territory, and in the neighbour's territory whenever the latter was temporarily away. The male frequently harboured the chicks under his wings. The female did not show any concern for the chicks.

Conclusions

A single season's observations on three adult birds are hardly sufficient to warrant definite conclusions. However, the following points are noteworthy:

(1) The male and female showed a difference in sexual excitability. The female periodically appeared to attain peaks of sexual excitement when she solicited copulation by posturing before the male. The male responded to 89% of these postures by covering. No such display by the male, or for that matter no other courtship action by either sex was observed. Huxley (1923) has pointed out that such disparity in sexual excitability in species with sexual dimorphism has the function of regulating coition. More sustained observations and of larger marked populations would determine whether both sexes of Bronzewinged Jaçanas indulge in courtship actions.

(2) When eggs are lost after the commencement of incubation, the pair revert to coition and nest-building once again. Huxley (1923) has recorded this reversal of behaviour in his discussion of evolution of breeding behaviour in birds.

(3) The males are very aggressive in the defence of their breeding territories.

(4) The female's territory covered the whole breeding area and her defensive action was directed against intruders of other species only. (In this case, however, there were no rival females.)

(5) The female policed the aggressive behaviour of the males against each other.

Comparing these observations on the Bronzewinged Jaçana with those of Hoffmann (1949) on the Pheasant-tailed Jaçana, one finds the following points in common:

(1) The female is larger in size and is polyandrous. A single female pairs with different males one after the other;

(2) Incubation and care of the young is done almost entirely by the male;

(3) The female defends the territory vigorously;

(4) The two sexes use the same type of calls in similar contexts; and the following points of difference:

(1) Hoffmann observed a single male Pheasant-tailed Jaçana rearing two to three families in a season and the parent-chick relation slackening in the second week. In the only brood of Bronzewinged Jaçanas that survived, the chicks were looked after by the male parent even after they were two months old. I did not observe a male Bronzewinged Jaçana rearing more than one family.

(2) Hoffmann has recorded that a single female produced 3-4 clutches within a month, or from 7 to 10 clutches within one season. The female studied this season produced, in all 4 clutches of 3-4 eggs within 2½ months.

(3) Hoffmann refers to very exceptional cases where the female shared incubation and care of young. No such instance was observed in the cases studied. More sustained observations are necessary to test this possibility.

Acknowledgements

I am indebted to Dr. Sálim Ali, Shri Humayun Abdulali, and to Shri J. C. Daniel for their guidance without which I could not have undertaken this work. Shri Abdulali kindly made his canoe available to me at the site of observation. I am grateful to my colleague Shri P. B. Shekar for his assistance. Shri Honkan, the Assistant Agricultural Officer in charge of the Powai Unit, and his staff were very helpful. I record my gratitude to them.

Summary

The female Bronzewinged Jaçana is larger than the male and is polyandrous. The female paired with two males one after the other. She did not share parental duties, but defended the breeding area vigorously. No courtship behaviour by the male was observed. The female solicited copulation by posturing near the male. Both sexes shared building, but the male alone incubated. When a clutch of eggs was lost after the commencement of incubation the pair reverted to coition and nest-building.

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Observations on the Vegetation of the Rampa and Gudem Agency Tracts of the Eastern Ghats—II

BY

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[*Continued from Vol.* **55** (3) : 449]

The systematic enumeration of the species that was to follow Part I of the paper, published in this Journal in 1958, could not be completed in time due to the frequent movement of the author on botanical exploration work.

177 new records for Angiosperms and 38 for Pteridophytes, which have not been reported so far from the Eastern Ghat ranges along the Andhra Coastal Region, are noted in this paper. Of these, *Alocasia decipiens* forms a new record for India, and the two species *Alectra sessiliflora* var. *monticola* and *Carex stramentita* are new for peninsular India. As the published data on the Pteridophyte flora of the Eastern Ghat ranges along the Andhra coast is very meagre, all the collections reported under Pteridophytes have turned out to be new records. Every effort has been made to present up-to-date nomenclature in the paper.

The author wishes to express his grateful thanks to the late V. Narayanswamy, formerly of the Botanical Survey of India, for valuable information given during the study of his collections by the author at the Calcutta Herbarium and to Rev. Father H. Santapau, S.J., Director, Botanical Survey of India, for going through the manuscript and for his kind encouragement. The author's thanks are also due to Shri K. C. Kanodia, Botanical Survey of India, Poona, for all his assistance in the preparation of the list.

ENUMERATION OF SPECIES

Note. This list includes all the species collected by the parties of the Botanical Survey of India from the Rampa and Gudem Agency Tracts and also those recorded by Gamble for this area.

ANGIOSPERMS

Ranunculaceae

Clematis gouriana Roxb. ex DC.—Near Nulakamaddi.
C. smilacifolia Wall.—Yarlagadda ; Gudem.
Naravelia zeylanica DC.—Komaravaram.

Dilleniaceae

Dillenia pentagyna Roxb.—Rampa Hill.

Annonaceae

Miliusa velutina Hook. f. & Thom.—Forests of Godavari Dist.
Polyalthia cerasoides (Roxb.) Hook.f.& Thom.—Ethakonda; Yarlagadda-Sesharayi.
P. suberosa (Roxb.) Thwaites—Devarapalli-Maredumalli.

Menispermaceae

Anamirta cocculus Wt. & Arn.—Gudem valley.
Cissampelos pareira Linn.—Nilavaram padu ; Rampa Hill ; Maredumalli.
Cocculus hirsutus (Linn.) Diels—Ramavaram.
Hypserpa cuspidata (Wall.) Miers—SE. Gudem.
Tinospora cordifolia (Willd.) Miers—Near Rayapalli.

Brassicaceae (=Cruciferae)

Nasturtium madagascariense DC.—Hills of Godavari Dist.

Capparidaceae

Capparis grandis Linn.f.—Godavari Dist.
C. zeylanica Linn.—Chinaudasakarru, near Rayapalli.
Cleome monophylla Linn.—Chodavaram-Rampa.
Crataeva nurvala Buch.-Ham.—Rampa.
Maerua arenaria Hook. f. & Thom.—Godavari Dist.

Violaceae

Hybanthus enneaspermus (Linn.) F. Muell.—Near Nulakamaddi ; Rampa.

Bixaceae

Cochlospermum religiosum (Linn.) Alston—Near Mattambhimavaram.

Flacourtiaceae

Flacourtia jangomas (Lour.) Raeusch.—Hills of Vizag. Dist.
F. indica Merr.—Chinaudasakarru, near Rayapalli ; Pasaruginni.

Pittosporaceae

Pittosporum floribundum Wt. & Arn.—Devarakonda.

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Polygalaceae

Polygala chinensis Linn.—Rampa Hill.
P. chinensis L.var. **linearifolia** Chodat—Bhupathipalem.
P. erioptera DC.—Godavari Dist.
P. rosmarinifolia Wt. & Arn.—Dummakonda top.

Caryophyllaceae

Drymaria diandra Bl.; Mizushima in Jour. Jap. Bot. 32 : 79, 1957—Ethakonda.
Polycarpaea corymbosa Lam.—Devarakonda ; Gurtedu-Dharakonda.

Portulacaceae

Portulaca oleracea Linn.—Near Chodavaram.
P. wightiana Wall.—Godavari Dist.

Malvaceae

Abelmoschus cancellatus Wall.—Yarlagadda-Mattambhimavaram.
A. manihot (L.) Medik. var. **pungens** (Roxb.) Hochr.—Nulakamaddi ; Sesharayi ; Yarlagadda ; Gudem valley.
Abutilon indicum (Linn.) Sw.—Maredumalli ; near Gurtedu.
A. polyandrum (Roxb.) Wt. & Arn.—Mattambhimavaram-Gurtedu ; Gudem-Ebul Reserve.
Gossypium mexicanum Tod.—Ramavaram.
Hibiscus furcatus Roxb.—Top of Palakonda, near Maredumalli.
H. hirtus Linn.—Godavari Dist.
H. micranthus Linn.f.—Rampa Hill.
H. radiatus Willd.—Borragudem. **Cultivated.**
H. lobatus (Murr.) O. Kuntze—Rampa Hill ; Gudem valley.
H. vitifolius Linn.—Peddakonda, near Marrivada ; Sesharayi ; Nulakamaddi.
Kydia calycina Roxb.—Sesharayi Hill.
Pavonia odorata Willd.—Bhupathipalem ; Rampa-Chodavaram.
P. zeylanica Cav.—Rampa Hill.
Sida acuta Burm.—Nulakamaddi-Ramavaram.
S. cordifolia Linn.—Chodavaram ; Rampa.
S. rhombifolia Linn.—Nulakamaddi-Ramavaram.
S. rhombifolia Linn. var. **rhomboidea** Mast.—Maredumalli.
S. veronicaefolia Lam.—Bhupathipalem.
Thespesia lampas (Cav.) Dalz. & Gibbs.—Base of Devarakonda ; near Sesharayi ; Nulakamaddi ; near Mattambhimavaram.
Urena lobata Linn.—Gudem valley ; Sesharayi ; Dummakonda.

Bombacaceae

Bombax ceiba Linn.; A. Robyns in Taxon 10 : 160, 1961—Yarlagadda.

Sterculiaceae

Byttneria herbacea Roxb.—Rampa ; Chodavaram.
Eriolaena hookeriana Wt. & Arn.—Mattambhimavaram ; Gudem.

Firmiana colorata R.Br.—Godavari District.
Helicteres isora Linn.—Ethakonda ; Gokavaram.
Melochia corchorifolia Linn.—Maredumalli ; Yarlagadda.
Pterospermum heyneanum Wall.—Buggimetta, near Rampa ; Ramavaram.
Sterculia villosa Roxb.—Sesharayi.
S. urens Roxb.—Foot of Rampa Hill.

Tiliaceae

Corchorus aestuans Linn.—Devarapalli.
C. fascicularis Lamk.—Godavari Dist.
Grewia abutilifolia Vent. ex Juss.—Top of Palakonda ; Maredumalli ; Dharakonda ; Ebul Reserve, Gudem.
G. glabra Bl.—Peddakonda ; Maredumalli ; Sesharayi ; Mattambhimavaram ; Dharakonda ; Gudem.
G. hirsuta Vahl—Chodavaram ; Rayapalli ; Yarlagadda ; Mattambhimavaram ; Gurtedu.
G. orbiculata Roth—Sesharayi.
G. polygama Roxb.—Godavari Dist.
G. rothii DC.—Ethakonda ; Sesharayi ; Dummakonda.
G. subinaequalis DC.—Peddakonda top ; Rampa.
G. tiliaefolia Vahl—Rayapalli ; Yarlagadda ; Dummakonda ; Gudem.
Triumfetta annua Linn.—Forests of Godavari Dist.
T. pilosa Roth—Dummakonda.
T. rhomboidea Jacq.—Devarapalli.
T. rotundifolia Lamk.—Rampa.

Linaceae

Erythroxylum monogynum Roxb.—Rampa-Chodavaram.
Hugonia mystax Linn.—Scrub forests of Godavari Dist.

Malpighiaceae

Aspidopterys indica (Roxb.) Hochr.—Rampa-Chodavaram ; Rayapalli.
Hiptage benghalensis (Linn.) Kurz—Yarlagadda-Mattambhimavaram.

Oxalidaceae

Biophytum sensitivum DC.—Chodavaram.
Oxalis corniculata Linn.—Nulakamaddi ; Sesharayi-Yarlagadda.
O. corniculata Linn. var. **stricta** Hook. f.—Dummakonda top.

Balsaminaceae

Impatiens balsamina Linn. var. **coccinea** (Wall.) Hook. f.—Maredumalli ; Dummakonda.

Rutaceae

Atalantia monophylla (Roxb.) DC.—Rampa Hill ; Devarakonda.
Evodia lunu-ankenda (Gaertn.) Merr.—Gudem valley.
Fagara budrunga Roxb.—Rampa Hill.

Glycosmis pentaphylla (Retz.) Corr.—Ramavaram.
Limonia crenulata Roxb.—Chodavaram.
Murraya koenigii (Linn.) Spreng.—Rampa Hill.
M. paniculata (Linn.) Jack.—Rampa.
Paramignya scandens (Griff.) Craib—Gudem Hill.
P. monophylla Wt.—Rampa Hill.
Toddalia asiatica (Linn.) Lamk.—Mattambhimavaram.
T. asiatica Lamk. var. **gracilis** Gamble—Foot of Rampa Hill.

SIMARUBACEAE

Ailanthus excelsa Roxb.—Gokavaram-Chodavaram ; Addatigala.
Balanites aegyptiaca (Linn.) Delile—Gokavaram-Chodavaram.

OCHNACEAE

Ochna gamblei King—Hills of Godavari Dist.

BURSERACEAE

Boswellia glabra Roxb.—Forests of Godavari Dist.
Garuga pinnata Roxb.—Chodavaram ; Peddakonda ; Rayapalli.
Protium serratum (Watt ex Colebr.) Engl.—Maredumalli metta ; Ebul Reserve Gudem.

MELIACEAE

Aglaia roxburghiana Miq.var. **beddomei** Gamble—Devarakonda ; Ethakonda.
Chloroxylon swietenia DC.—Foot of Rampa Hill ; Ramavaram.
Cipadessa baccifera (Roth) Miq.—Rayapalli ; Sesharayi.
Heynea trijuga Roxb.—Rampa Hill.
Soymida febrifuga A. Juss.—Addatigala-Rayapalli.
Toona ciliata Roem.—Rampa Hill.
Walsura piscidia Roxb.—Rampa.

OLACACEAE

Olax scandens Roxb.—Maredumalli ; Kota.
Ximenia americana Linn.—Jungles of Godavari Dist.

CELASTRACEAE

Celastrus paniculata Willd.—Rampa Hill.
Elaeodendron glaucum Pers.—Palakonda ; Errangondi ; Dummakonda ; Gudem-Marripakalu.
Gymnosporia bailadillana Narayan. et Mooney—Gudem ; Gudem-Marripakalu.
Maytenus senegalensis (Lam.) Exell. (= *G. spinosa* Fiori)—Rayapalli.
Pleurostylia wightii Wt. & Arn.—Forests of Godavari Dist.

RHAMNACEAE

Gouania leptostachya DC.—Sesharayi.
Helinus lanceolatus Brand.—Hills of Godavari Dist.
Sageretia parviflora G.Don—Rekapalli in Godavari Dist.

Ventilago calyculata Tul.—Rampa Hill ; Sreepuram ; Chidipalem.
Zizyphus mauritiana Lamk.—Ramavaram.
Z. mauritiana Lamk. var. **fruticosa** Haines—Forests of Godavari Dist.
Z. oenoplia (Linn.) Mill.—Rampa Hill ; Kota-Ramavaram ; Chidipalem.
Z. rugosa Lamk.—Maredumalli ; down Gangadevi ghat ; Gudem-Marripakalu.
Z. xylopyra (Retz.) Willd.—Rampa ; Ebul Reserve, Gudem.

Vitaceae

Ampelocissus tomentosa Planch—Palakonda top.
Cayratia auriculata (DC.) Gamble—Rampa Hill.
C. carnosa Gagnep.—Gunjugudem.
C. pedata (Wall.) Gagnep.—Gokavaram, near Chodavaram.
Cissus pallida (Wt. & Arn.) Planch.—Above Boggimetta, Rampa.
C. woodrowii (Stapf) Santapau—Gokavaram, near Chodavaram.
Leea edgeworthii Santapau—Hills of Godavari Dist.
L. indica (Burm.) Merr.—Rampa Hill ; Sesharayi.
L. robusta Roxb.—Hills of Godavari Dist.
Vitis lanata Roxb.—Hills of Godavari Dist.

Sapindaceae

Allophyllus serratus (Roxb.) Radlk.—Borrugudem, Rampa area.
Cardiospermum halicacabum Linn.—Rampa Hill.
Dodonaea viscosa (Linn.) Jacq.—Addatigala-Rayapalli.
Sapindus emarginatus Vahl—Near Rampa.

Anacardiaceae

Buchanania lanzan Spr.—Near Rayapalli ; Dummakonda.
Mangifera indica Linn.—Rampa ; Sesharayi ; Gudem etc.
Rhus paniculata Wall.—Rampa Hill.
R. parviflora Roxb.—Higher hills of Rampa area.
Semecarpus anacardium Linn.f.—Gokavaram-Chodavaram ; Mattambhimavaram.

Moringaceae

Moringa oleifera Lamk.—Forests of Godavari Dist.

Fabaceae (=Papilionaceae)

Abrus precatorius Linn.—Peddakonda.
Aeschynomene indica Linn.—Chiruvupalem.
Alysicarpus pubescens Law—Hills of Godavari Dist.
A. vaginalis DC.—Nilavarampadu, near Gudem.
Atylosia albicans Benth.—Nulakamaddi ; Ethakonda.
A. scarabaeoides Benth.—Bhupathipalem ; Ethakonda ; Chinaudasakarru.
Cajanus cajan (Linn.) Millsp.—Gudem valley, perhaps grown from seeds dropped by pedestrians.
Canavalia virosa (Roxb.) Wt. & Arn.—Rampa.
Crotalaria albida Heyne ex Roth.—Rampa Hill ; Dummakonda ; Dharakonda top, on way to Gudem.

Crotalaria calycina Schrank—Kappakonda.
C. evolvuloides Wt.—Nulakamaddi.
C. hirsuta Willd.—Rampa Hill.
C. hirta Willd.—Forests of Godavari Dist.
C. juncea Linn.—Pulusupalem—wild and cultivated.
C. linifolia Linn. f.—Rampa Hill.
C. medicaginea Lamk. var. **typica** Gamble—Rampa Hill.
C. prostrata Rottl.—Borragudem.
C. ramosissima Roxb.—Dry stony lands of Godavari Dist.
C. trifoliastrum Willd.—Rampa Hill ; Dummakonda.
C. umbellata Wt.—Dummakonda.
Cylista scariosa Roxb.—Chinaudasakarru ; near Yarlagadda.
Dalbergia lanceolaria Linn.f.—Panasalapalem-Rayapalli.
D. latifolia Roxb.—Chodavaram ; Ethakonda.
D. volubilis Roxb.—Gurtedu-Dharakonda.
Derris scandens (Roxb.) Benth.—Chiruvupalem ; Addatigala.
Desmodium brachystachyum Grah.—Kappakonda.
D. triangulare (Retz.) Merrill—Maredumalli; Peddakonda near Rampa Hill; Ebul Reserve Forest.
D. gangeticum (Linn.) DC.—Chodavaram-Rampa ; foot of Rampa Hill; Ebul Reserve Forest.
D. gyrans DC.—On way to Dummakonda ; Nulakamaddi-Yarlagadda.
D. heterophyllum DC.—Ebul Reserve Forest, near Gudem.
D. latifolium DC.—Rampa Hill ; Ethakonda.
D. laxiflorum DC.—Maredumalli ; Ethakonda.
D. parviflorum (Dalz.) Baker—Sesharayi—New Record for Eastern Ghats.
D. polycarpum (Poir.) DC.—Kappakonda.
D. pulchellum Benth.—Peddakonda ; Rayapalli.
D. triflorum (Linn.) DC.—Bhupathipalem.
D. triquetrum (Linn.) DC.—Near Sesharayi ; Ebul Reserve.
Dolichos falcatus Klein.—On way to Gunjugudem.
D. lablab Linn.—Dharakonda. Cultivated.
Dunbaria ferruginea Wt. & Arn.—Nulakamaddi-Yarlagadda.
Galactia longifolia Benth.—Rampa-Chodavaram—New record for Eastern Ghats.
G. tenuiflora Wt. & Arn.—Dummakonda.
Heylandia latebrosa (Linn.) DC.—Chinaudasakarru.
Indigofera glandulosa Roxb. ex Willd.—Godavari Dist.
I. hirsuta Linn.—Foot of Rampa Hill ; Sesharayi-Dummakonda.
I. linifolia Retz.—Pedda Geddada.
I. pulchella Roxb.—Kota-Ramavaram ; Chinaudasakarru ; on way to Dummakonda.
I. trifoliata Linn.—Peddakonda, near Rampa Hill ; Borrugudem.
I. trita Linn.f.—Godavari Dist.
I. viscosa Lamk.—Godavari Dist.
Millettia auriculata Baker—Dharakonda.
Moghania lineata (Linn.) O.Kuntze—Forests of upper Godavari area.
M. praecox (Cl. ex Prain) H.L.Li var. **robusta** Mukerjee in Bull. Bot. Soc. Bengal 6 : 19, 1952—Peddakonda ; Gudem valley.
M. stricta (Roxb.) O.Kuntze—Ethakonda ; Sesharayi ; Gudem Camp.
M. strobilifera (Linn.) St. Hill. ex Jacks.—Ethakonda ; Gudem valley.
Mucuna monosperma DC.—Yarlagadda-Sesharayi.
Ougeinia dalbergioides Benth.—Gurtedu-Dharakonda.

Phaseolus aconitifolius Jacq.—Bhupathipalem.
P. calcaratus Roxb.—Rampa Hill top.
Pongamia pinnata (Linn.) Pierre—Marrivada-Gunjugudem.
Pseudarthria viscida (Linn.) Wt. & Arn.—Maredumalli ; Ethakonda.
Pterocarpus marsupium Roxb.—Maredumalli ; Dummakonda.
Rhynchosia cana DC.—Chinaudasakarru.
R. rufescens DC.—Nilavarampadu, near Gudem.
Rothia trifoliata Pers.—Devarapalli.
Shuteria vestita Wt. & Arn.—Dharakonda-Gudem.
Tephrosia lanceolata Grah.ex Wt. & Arn.—Godavari Dist.
T. purpurea Pers.—Rampa Hill ; Maredumalli ; Sesharayi.
T. roxburghiana Drumm.—Dummakonda, near the top.
T. tinctoria Pers.—Ethakonda.
Teramnus labialis (Linn.f.) Spr.—Mattambhimavaram-Gurtedu.
T. labialis (Linn.f.) Spr.var. **mollis** Baker—Sesharayi.
Uraria rufescens (DC.) Schindl. ; van Steenis in Reinwardtia 5, 453, 1961—Ethakonda.
Zornia diphylla Pers.—Chodavaram-Rampa.

Caesalpiniaceae

Bauhinia malabarica Roxb.—Sreepuram ; near Kota ; near Sesharayi ; near Gudem .
B. purpurea Linn.—Peddakonda ; Ramavaram ; near Chinaudasakarru.
B. racemosa Lamk.—Rampa Hill ; Addatigala.
B. vahlii Wt. & Arn.—Maredumalli ; Sesharayi.
Caesalpinia digyna Rottl.—Bhupathipalem.
Cassia absus Linn.—Rampa Hill.
C. auriculata Linn.—Near Chodavaram.
C. fistula Linn.—Devarapalle.
C. mimosoides Linn.—Devarakonda.
C. occidentalis Linn.—Rampa.
C. pumila Lamk.—Rampa Hill slopes.
Hardwickia binata Roxb.—Upper Godavari forests.
Pterolobium indicum A.Rich.—Godavari forests.
Tamarindus indica Linn.—Ramavaram ; Yarlagadda.

Mimosaceae

Acacia concinna DC.—Pasaruginni ; Gurtedu-Dharakonda.
A. pennata (Linn.) Willd.—Rampa Hill.
A. chundra (Roxb.) Willd.—Chodavaram ; Rampa.
A. suma Buch.-Ham.—Judeng Forest, Godavari.
A. tomentosa Willd.—Godavari Dist.
A. torta (Roxb.) Craib—Hills of Godavari Dist.
Albizzia amara Boivin—Rampa Hill.
A. marginata Merr.—Nilavarampadu, near Gudem.
A. odoratissima (Linn.f.) Benth.—Chodavaram-Devipatnam ; Nilavarampadu, near Gudem.
Dichrostachys cinerea (Linn.) Wt. & Arn.—Pasaruginni ; Yarlagadda ; Mattambhimavaram.
Entada pursaetha DC.—Yarlagadda-Sesharayi.
Mimosa angustisiliqua Gamble—Forests of Godavari Dist.

Mimosa rubicaulis Lamk.—Chodavaram-Rampa ; Sesharayi-Yarlagadda.
Prosopis spicigera Linn.—Forests of Godavari Dist.
Xylia xylocarpa (Roxb.) Taub.—Dummakonda.

Rosaceae

Pygeum acuminatum Coleb.—Gudem valley.

Crassulaceae

Bryophyllum pinnatum (Lamk.) Oken—Near Maredumalli village, probably introduced.

Droseraceae

Drosera burmanni Vahl—Devarakonda.
D. indica Linn.—Devarakonda.

Combretaceae

Anogeissus acuminata Wall.—Forests of Godavari Dist.
A. latifolia Wall.—Bhupathipalem ; Sreepuram ; Chinaudasakarru ; Sesharayi Hill.
Combretum decandrum Roxb.—Yarlagadda-Sesharayi ; Sesharayi Hill.
Terminalia arjuna Wt. & Arn.—Gunjugudem.
T. bellerica (Gaertn.) Roxb.—Rayapalli; Yarlagadda-Dummakonda.
T. chebula Retz.—Chodavaram-Rampa ; Yarlagadda.
T. chebula Retz. var. **tomentella** Cl.—Forests of Godavari Dist.
T. tomentosa Wt. & Arn.—Near Chodavaram ; Dharakonda-Gudem.

Myrtaceae

Syzygium cumini (Linn.) Skeels—Chodavaram ; Rampa.

Lecythidaceae

Careya arborea Roxb.—Chinaudasakarru ; Chimalabanda along Gudem to Marripakalu.

Melastomaceae

Melastoma malabathricum Linn.—Peddakonda ; Yarlagadda ; Sesharayi Hill.
Memecylon gracile Bedd.—Gudem Hill slope.
Osbeckia chinensis Linn.—Palakonda.
O. octandra DC.—Gudem valley.
Sonerila tenera Royle—Dummakonda top.

Lythraceae

Ammania baccifera Linn.—Chinaudasakarru.
Lagerstroemia parviflora Roxb.—Near Chodavaram ; Rayapalli ; Yarlagadda Mattambhimavaram.

Lagerstroemia parviflora Roxb. var. **majuscula** Cl.—Rampa Hill.

Woodfordia fruticosa (Linn.) Kurz—Rayapalli ; Pasaruginni.

Onagraceae

Jussiaea suffruticosa Linn.—Chodavaram-Rampa ; Nulakamaddi-Yarlagadda.

Ludwigia prostata Roxb.—Ramavaram—New Record for Eastern Ghats.

Samydaceae

Casearia graveolens Dalz.—Gurtedu-Dharakonda ; Ebul Reserve Forest.

C. tomentosa Roxb.—Yarlagadda ; Ethakonda ; Dummakonda Hill ; Komaravaram-Yarlagadda ; Yarlagadda-Mattambhimavaram.

Homalium nepalense Benth.—Rampa Hill.

H. zeylanicum Benth.—Rampa Hill.

Cucurbitaceae

Bryonopsis laciniosa (Linn.) Naud.—Ramavaram.

Coccinia cordifolia (Linn.) Cogn. Chakravarthy in Rec. Bot. Sur. Ind. **17** : 117, 1959—Kota.

Cucumis melo Linn.—Bhupathipalem.

C. melo Linn. var. **agrestis** Naud.—Devarapalli.

C. sativus Linn.—Chintagandi Hill, near Maredumalli.

Melothria heterophylla (Lour.) Cogn.—Borragudem.

M. leiosperma Cogn.—Near Nulakamaddi.

M. maderaspatana (Linn.) Cogn.—Near Devarapalli ; top of Dummakonda ; near Chidipalem.

M. perpusilla Cogn.—Ethakonda ; Sesharayi-Nulakamaddi.

Momordica charantia Linn.—Rampa.

Trichosanthes bracteata (Lamk.) Voigt—Rampa-Chodavaram.

Begoniaceae

Begonia malabarica Lamk.—Ethakonda ; Yarlagadda ; Sesharayi ; SE. Gudem.

B. picta Sm.—Maredumalli.

Molluginaceae

Mollugo pentaphylla Linn.—Devarakonda ; Rampa Hill ; near Gunjugudem.

Gisekia pharnacioides Linn.—Waste lands of Godavari Dist.

Apiaceae (=Umbelliferae)

Bupleurum mucronatum Wt. & Arn.—Gudem valley.

Centella asiatica (Linn.) Urban—Yarlagadda-Sesharayi.

Pimpinella heyneana Wall.—Ethakonda ; NW. slopes of Dharakonda.

P. monoica Dalz.—Dummakonda ; Gangadevi ghat of Gudem-Marripakalu.

Araliaceae

Schefflera stellata Harms.—Rampa Hill; Yarlagadda-Sesharayi; Ebul Reserve, Gudem.

Rubiaceae

Adina cordifolia Hook.f.—NE. slope of Sesharayi; Yarlagadda; Mattambhimavaram.
Anthocephalus indicus A.Rich.—Along Godavari River.
Borreria hispida (Linn.) Schum.—Rampa Hill; Devarapalli.
B. stricta (Linn.f.) Schum.—Rampa Hill; Buggimatta; Rampa-Chodavaram; Dummakonda.
Canthium dicoccum (Gaertn.) Merr.—Yarlagadda; Sesharayi; Gudem-Marripakalu; Borrigudem.
Chasalia curviflora Thw.—Gudem valley.
Coffea arabica Linn.—Malapalle, near Gudem. Cultivated.
Gardenia latifolia Ait.—Eastern slope of Dummakonda.
G. turgida Roxb.—Yarlagadda-Mattambhimavaram; Maredumalli metta.
Hamiltonia suaveolens Roxb.—Sesharayi-Dummakonda.
Ixora arborea Roxb. ex Sm.—Chinaudasakarru.
Knoxia corymbosa Willd.—Yarlagadda-Sesharayi; Palakonda.
Neonauclea purpurea Merr.—Rampa Hill; Yarlagadda metta.
Oldenlandia auricularia (Linn.) K. Schum.—Kota.
O. biflora Linn.—Dummakonda.
O. corymbosa Linn.—Devarakonda.
O. dichotoma Koenig—Bhupathipalem; Borrigudem.
O. diffusa Roxb.—Kota.
O. nitida Gamble —Gudem valley.
O. nudicaulis Roth—Rampa-Chodavaram; Maredumalli metta.
Pavetta indica Linn. var. **tomentosa** Hook.f.—Maredumalli; Gokavaram; Ebul Reserve, near Gudem.
Psychotria fulva Ham.—SE. slope of Gudem Hill.
Randia dumetorum Lamk.—Chinaudasakarru; Nilavarampadu.
R. malabarica Lamk.—Hills of Godavari District.
R. uliginosa DC.—Gurtedu-Dharakonda.
Rubia cordifolia Linn.—Ethakonda; Yarlagadda-Sesharayi; Dummakonda; Gudem valley.
Tarenna asiatica (Linn.) O.Kuntze—Rayapalli.
Wendlandia exserta DC.—Gurtedu-Dharakonda.
W. gamblei Cowan—Gudem valley.
W. glabrata DC.—Gudem Hills.
W. tinctoria DC.—Hills of Godavari Dist.

Asteraceae (= Compositae)

Adenostemma lavenia (Linn.) O.Kuntze—Gudem valley; Sesharayi.
Ageratum conyzoides Linn.—Maredumalli.
Bidens bipinnata Linn.—Nulakamaddi.
Blainvillea acmella (L. f.) Philip—Rampa Hill.
Blumea fistulosa (Roxb.) Kurz; Randeria in Blumea **10**: 256, 1960.—Rampa Hill.

Blumea membranacea DC. var. **jacquemontii** (Hook. f.) Randeria, l.c., 269.—Rampa Hill.

B. virens DC.—Chinaudasakarru ; Ethakonda.

Caesulia axillaris Roxb.—Yarlagadda.

Centratherum anthelminticum O. Kuntze—Sesharayi.

Cosmos sp.—Peddakonda. (Cultivated)

Conyza stricta Willd.—Devarakonda.

Cyathocline purpurea (Don) O. Kuntze—Gurtedu-Dharakonda.

Eclipta prostrata Linn.—Sesharayi ; Gudem ; Rampa-Chodavaram.

Elephantopus scaber Linn.—Rampa Hill.

Emilia sonchifolia (Linn.) DC.—Devarapalli.

Gnaphalium indicum Linn.—Gurtedu.

Gynura angulosa DC.—Gudem valley.

G. lycopersicifolia DC.—Palakonda.

Laggera alata (Don) Sch.-Bip. ex Oliv.—Nilavaram.

L. pterodonta Benth.—Dharakonda.

Senecio nudicaulis Buch.-Ham.—Hills of Godavari Dist.

Siegesbeckia orientalis Linn.—Yarlagadda.

Sphaeranthus indicus Linn.—Yarlagadda.

Spilanthes acmella Merr.—Yarlagadda-Sesharayi.

Synedrella nodiflora Gaertn.—Dharakonda.

Tridax procumbens Linn.—Devarapalli.

Vernonia albicans DC.—Dummakonda.

V. cinerea Less.—Chinaudasakarru ; Rampa Hill.

V. divergens Edgew.—Sesharayi ; Gurtedu-Dharakonda ; Gudem valley.

Vicoa indica DC.—Chinaudasakarru ; Devarakonda.

CAMPANULACEAE

Lobelia heyneana Roem. & Sch.—Dummakonda.

PLUMBAGINACEAE

Plumbago zeylanica Linn.—Sesharayi-Yarlagadda ; near Nulakamaddi.

PRIMULACEAE

Anagallis pumila Swartz—Hills of Godavari Dist.

MYRSINACEAE

Ardisia solanacea (Poir.) Roxb.—Chinaudasakarru ; Peddakonda Hill ; Ethakonda.

Embelia tsjeriam-cottam (R. & S.) A. DC.—SE. Gudem Camp.

E. ribes Burm.—Gudem valley, near streams.

SAPOTACEAE

Donella roxburghii (G. Don) Pierre ex Lecomte.—Rampa Hill.

Madhuca longifolia (Koenig) MacBride var. **latifolia** (Roxb.) Chevalier ; van Royen in Blumea **10** : 53, 1960—Forests of Godavari Dist.

Xantolis tomentosa (Roxb.) Rafin.—Dummakonda ; Gangadevi ghat ; Ramavaram-Sesharayi.

Ebenaceae

Diospyros candolleana Wt.—Rampa Hill.
D. chloroxylon Roxb.—Rampa Hill ; Kota.
D. melanoxylon Roxb.—Ramavaram.
D. peregrina (Gaertn.) Gurke—Gurtedu-Dharakonda.
D. sylvatica Roxb.—Yarlagadda-Sesharayi ; Komaravaram, near Yarlagadda.
D. tomentosa Roxb.—Dummakonda ; Gokavaram-Chodavaram.

Oleaceae

Jasminum auriculatum Vahl—Rampa Hill.
J. scandens Vahl—Gudem valley.
Linociera malabarica Wall.—Ethakonda ; Yarlagadda-Sesharayi ; Gudem valley ; Ebul Reserve, north of Gudem.
L. ramiflora (Roxb.) Wall. ex G. Don—Kota; Rampa Hill.
Ligustrum walkeri Dcne.—Gudem valley.
Nyctanthes arbor-tristis Linn.—Near Mattambhimavaram ; Rampa-Chodavaram.
Schrebera swietenioides Roxb.—Maredumalli ; Palakonda ; Chinaudasakarru ; Yarlagadda, Mattambhimavaram.

Salvadoraceae

Azima tetracantha Lamk.—Gokavaram.

Apocynaceae

Aganosma dichotoma K. Schum.—SE. Gudem camp.
Alstonia venenata R. Br.—Hills of Godavari Dist.
Ervatamia coronaria Stapf—Maredumalli.
Holarrhena antidysenterica Wall.—Gokavaram-Chodavaram.
Ichnocarpus frutescens R. Br.—Ramavaram ; Rampa Hill.
Lochnera pusilla K. Sch.—Marrivada.
Rauvolfia densiflora Benth. ex Hook.f.—Rampa Hill.
R. serpentina Benth.—Maredumalli.
Wrightia tomentosa Roem. & Sch.—Sesharayi-Nulakamaddi ; Sesharayi.

Asclepiadaceae

Caralluma adscendens R. Br.—Rampa area.
Ceropegia hirsuta Wt. & Arn.—Borragudem.
C. tuberosa Roxb.—Rampa Hill ; Borragudem.
Cryptolepis buchanani Roem. & Sch.—Ebul Reserve, north of Gudem.
C. elegans Wall.—Hills of Godavari Dist.
Cryptostegia grandiflora R. Br.—Rampa-Chodavaram. (Probably an escape)
Gymnema sylvestre R. Br. ex Schult.—Kunjumveedi.
Hemidesmus indicus R. Br.—Near Yarlagadda.
H. indicus Schult. var. **pubescens** Wt.—Rampa Hill ; Gunjugudem.
Heterostemma tanjorense Wt. & Arn.—Rampa Hill.
Hoya iconum Sant.—Ethakonda.

Pergularia daemia (Forsk.) Choiv.—Gokavaram-Chodavaram.
Sarcostemma acidum (Roxb.) Voigt—Rampa Hill.
Toxocarpus kleinii Wt. & Arn.—On the Godavari bank.
Tylophora sp.—Nulakamaddi-Yarlagadda.
T. fasciculata Ham.—Rampa area.
T. rotundifolia Ham.—Rampa area.

Loganiaceae

Strychnos nux-vomica Linn.—Rampa Hill.
S. potatorum Linn.f.—Chinaudasakarru ; Maredumalli metta.

Gentianaceae

Canscora decurrens Dalz.—Hills of Godavari Dist.
C. diffusa R. Br.—Chinaudasakarru.
Exacum bicolor Roxb.—Dummakonda.
E. tetragonum Roxb.—Near Maredumalli ; Gurtedu-Dharakonda ; Burugupalem-Ramavaram.
Swertia angustifolia Buch.-Ham. var. **pulchella** Burkill—Dummakonda.

Hydrophyllaceae

Hydrolea zeylanica Vahl—Gudem valley.

Boraginaceae

Cynoglossum glochidiatum Wall.—Chintagondi Hill.
Ehretia laevis Roxb.—Ebul Reserve, north of Gudem.
Rotala aquatica Lour.—River banks in Rampa.

Convolvulaceae

Argyreia daltonii C. B. Clarke—Godavari Dist.
A. involucrata C. B. Clarke—Peddakonda.
A. nervosa (Burm. f.) Boj.—Pasaruginni, near Yarlagadda ; Rampa Hill.
A. strigosa (Roth) Sant. & Patel—Gudem valley.
Bonamia semidigyna (Roxb.) Hall.f.—Forests of Godavari.
Erycibe wightiana Grah.—Hills of Godavari Dist.
Evolvulus alsinoides (Linn.) Linn.f.—Rice fields near Sesharayi ; Guramanda Rampa Hill ; Dummakonda.
Hewittia sublobata (Linn.f.) O. Kuntze—Near Nulakamaddi.
Ipomoea alba Linn.—Maredumalli.
I. muricata (Linn.) Jacq.—Borrugudem.
I. nil (Linn.) Roth—Dummakonda Hill.
I. obscura Ker-Gawl.—Kota.
I. pes-tigridis Linn.—Rampa Hill.
I. wightii Choisy—Hills of Vizagapatam Dist.
Merremia tridentata Hall.f.—Gunjugudem.
M. tridentata (Linn.) Hall. f. subsp. **hastata** (Desr.) Ooststr.—Rampa-Chodavaram.

Merremia umbellata (Linn.) Hall. f.—Near Nulakamaddi.

M. vitifolia (Burm. f.) Hall. f.—On way to Dummakonda ; near Nulakamaddi ; Gudem valley.

Operculina petaloidea (Choisy) Ooststr.—Godavari Dist.

O. turpethum (Linn.) Silva-Manso—Gudem ; Dharakonda.

Rivea hypocrateriformis Choisy—Chinavuppalem.

SOLANACEAE

Capsicum minimum Roxb.—Sesharayi.

Datura metel Linn.—Kota.

Physalis minima Linn.—Marrivada.

Solanum giganteum Jacq.—Nilavarampadu ; near Gudem Camp.

S. melongena Linn.—Rampa Hill ; Sreepuram.

S. melongena Linn. var. **insanum** Prain—Rampa Hill ; Peddakonda.

S. nigrum Linn.—Devarapalli.

S. verbascifolium Linn.—Maredumalli.

SCROPHULARIACEAE

Alectra sessiliflora (Vahl) O. Kuntze var. **monticola** (Engl.) Melch. ; Hepper in Kew Bull. 1960 : 416.—Dummakonda—A new record for peninsular India.

A. thomsoni Hook. f.—Ethakonda. (Nomenclatural change of *Alectra* to *Melasma* has not been accepted at Kew as the latter does not include any parasites.)

Limophila rugosa (Roth) Merr.—Rampa Hill.

Lindernia anagallis Penn.—Ethakonda.

L. ciliata (Colsm.) Penn.—Rampa Hill ; Puttapalli.

L. cordifolia (Colsm.) Merr.—Banks of the Kanneru near Kota.

L. crustacea (Linn.) F. v. Muell.—Devarapalli ; Maredumalli.

L. pyxidaria Allioni—In the upper Godavari area.

Scoparia dulcis Linn.—Nilavarampadu ; Rampa-Chodavaram.

Sopubia trifida Ham.—Dummakonda Hill.

Striga asiatica (Linn.) O. Kuntze—Bhupathipalem ; Kappakonda.

S. euphrasioides (Vahl) Benth.—Rampa.

Torenia thouarsii (Cham. & Schlecht.) O. Kuntze—Godavari Dist.

OROBANCHACEAE

Aeginetia indica Linn.—Maredumalli.

GESNERIACEAE

Didymocarpus pygmaea C. B. Clarke—Rampa Hill.

Epithema carnosum Benth.—Dummakonda ; Devarakonda.

BIGNONIACEAE

Dolichandrone falcata Seem.—Upper Godavari area.

Heterophragma quadriloculare (Roxb.) K. Schum.—Godavari bank forests.

Oroxylum indicum (Linn.) Vent.—Rampa Hill ; Cheruvupalem.

Radermachera xylocarpa (Roxb.) K. Schum.—Hills of Godavari Dist.

PEDALIACEAE

Martynia annua Linn.—Gokavaram.
Sesamum indicum Linn.—Peddakonda. Escape from cultivation.

ACANTHACEAE

Adhatoda vasica Nees—Rampa Hill.
Andrographis echioides Nees—Rampa Hill.
A. ovata Benth.—Ethakonda ; Chintalapudi near Yarlagadda ; Sesharayi-Guramanda.
A. paniculata Nees—Rampa Hill ; Bhupathipalem.
Asteracantha longifolia Nees—Gunjugudem.
Barleria cristata Linn.—Kota ; Rampa-Chodavaram.
B. courtallica Nees—Rampa Hill.
B. montana Nees—Godavari River bank.
B. prionitis Linn.—Rampa-Chodavaram.
B. strigosa Willd.—Devarakonda ; Ethakonda ; Yarlagadda-Sesharayi.
Blepharis maderaspatensis (Linn.) Heyne ex Roth—Bhupathipalem ; Chinaudasakarru.
B. molluginifolia Pers.—Rampa Hill.
Cardanthera uliginosa Buch.-Ham.—Godavari Dist.
Dicliptera parvibracteata Nees—Rampa Hill.
Dyschoriste vagans (Wight) O. Kuntze—Gudem valley.
Ecbolium viride (Forsk.) Alston var. **dentata** (Cl.) Raizada—Nulakamaddi.
Elytraria acaulis (Linn.f.) Lindau—Gunjumveedi.
Eranthemum capense Linn.—Forests of Godavari Dist.
E. purpurascens Nees—Mattambhimavaram ; Chinaudasakarru.
Hemigraphis latebrosa Nees—Yarlagadda-Ethakonda.
Hygrophila salicifolia (Vahl) Nees—Godavari Dist.
Justicia betonica Linn. var. **villosa** C. B. Clarke—Devarakonda ; Pasaruginni near Yarlagadda.
J. diffusa Willd.—Devarakonda.
J. diffusa Willd. var. **vahlii** C. B. Clarke—Rampa Hill; Kota ; Dummakonda.
J. glabra Koen.—Bulasipalem; Ethakonda ; Nulakamaddi ; Ramavaram.
J. glauca Rottl.—Rampa Hill ; Sesharayi-Guramanda.
J. simplex D. Don—Dharakonda-Gudem.
Lepidagathis cuspidata Nees—NE. slopes of Sesharayi.
L. fasciculata Nees—Devarakonda ; Yarlagadda-Ethakonda.
L. hamiltoniana Wall.—Gudem valley.
L. incurva D. Don—Dharakonda.
Nelsonia campestris R. Br.—Chinaudasakarru.
Petalidium barlerioides Nees—Rampa Hill.
Phaulopsis dorsiflora (Retz.) Santapau—Yarlagadda-Ethakonda.
Rhinacanthus nasuta (Linn.) Kurz—Dharakonda top ; on way to Gudem.
Rungia parviflora Nees—Eastern slope of Dummakonda.
R. repens Nees—Godavari Dist.
Strobilanthes cuspidatus T. And.—Lower slope of Sesharayi Hill.
S. jeyporensis Bedd.—Hills of Godavari Dist.
Thunbergia fragrans Roxb. var. **heterophylla** Wall.—Bhupathipalem.
T. fragrans Roxb. var. **vestita** Nees—Dummakonda.
T. laevis Nees—Devarakonda ; Ebul Reserve, north of Gudem.

Verbenaceae

Callicarpa arborea Roxb.—Dharakonda Hill slope.

Clerodendrum serratum (Linn.) Moon—Peddakonda ; Palakonda.

Gmelina arborea Roxb.—Yarlagadda-Mattambhimavaram ; eastern slope of Dummakonda.

G. asiatica Linn.—Peddakonda.

Lantana camara Linn. var. **aculeata** (Linn.) Mold.—Gudem.

Premna flavescens Ham.—Devarapalli.

Vitex peduncularis Wall. var. **roxburghiana** C. B. Clarke—Ethakonda ; NE. slope of Sesharayi.

V. pubescens Vahl—Gokavaram-Chodavaram.

Lamiaceae (=Labiatae)

Acrocephalus indicus (Burm.) O. Kuntze—Godavari Dist.

Ajuga macrosperma Wall. var. **breviflora** Hook. f.—Mattambhimavaram-Gurtedu.

Anisochilus carnosus Wall.—Palakonda ; Devarakonda.

Anisomeles indica (Linn.) O. Kuntze—Nulakamaddi ; south-east of Gudem ; Erragondi.

Colebrookea oppositifolia Smith—Ethakonda.

Dysophylla myosuroides Benth.—Top of Dummakonda ; near Dharakonda falls.

D. quadrifolia Benth.—NE. slope of Sesharayi Hill ; Palakonda.

Leucas aspera Spreng.—Ramavaram.

L. cephalotes Spreng.—Rampa-Chodavaram.

L. marrubioides Desf.—Devarakonda.

L. mollissima Wall.—Ebul Reserve, north of Gudem ; Rampa Hill.

L. stricta Benth.—Godavari Dist.

Ocimum adscendens Willd.—Rampa Hill.

O. americanum Linn.—Foot of Ethakonda.

O. gratissimum Linn.—Near Nulakamaddi.

Orthosiphon thymiflorus (Roth) van der Sleesen in Reinwardtia 5 : 42, 1959—Devarapalli ; Devarakonda.

O. pallidus Royle—Godavari Dist.

O. rubicundus Benth.—Kunjumveedi ; Ethakonda.

Plectranthus coetsa Buch.-Ham.—SE. of Gudem Camp.

Pogostemon plectranthoides Desf.—Yarlagadda-Sesharayi ; Dummakonda ; NE. slope of Sesharayi Hill ; SE. of Gudem camp.

Scutellaria violacea Heyne—Gudem valley ; Dummakonda Hill.

Nyctaginaceae

Boerhavia diffusa Linn.—Bhupathipalem.

Mirabilis jalapa Linn.—Sesharayi. Cultivated.

Pisonia aculeata Linn.—Godavari Dist.

Amaranthaceae

Aerva lanata (Linn.) Juss.—Rampa Hill.

A. monsoniae (Linn.f.) Mart.—Peddapuram.

A. sanguinolenta (Linn.) Blume—Ethakonda ; Sesharayi ; Pasaruginni.

Alternanthera sessilis R. Br.—Cheruvupalem ; Rampa-Chodavaram ; Gurtedu-Dharakonda ; Nilavarampadu ; Sesharayi slope.

Amaranthus spinosus Linn.—Devarapalli ; Bulasipalem.

Amaranthus viridis Linn.—Devarapalli.

Celosia argentea Linn.—Bhupathipalem.

Pupalia atropurpurea Moq.—Chintapalli ; Yarlagadda-Ethakonda ; Nulakamaddi.

P. lappacea Moq.—Rampa-Chodavaram ; Chintapalli ; Nulakamaddi.

Polygonaceae

Polygonum barbatum Linn.—Chinaudasakarru ; Komaravaram ; Yarlagadda-Mattambhimavaram ; Geddada.

P. chinense Linn.—Gudem valley ; SE. of Gudem Camp ; Devarakonda.

P. flaccidum Meissn.—Near Sesharayi ; Maredumalli.

P. glabrum Willd.—Rampa-Chodavaram.

P. hydropiper Linn.—Gudem Camp-Nilavaram.

Rumex nigricans Hook.f.—Godavari Dist.

Podostemaceae

Hydrobryum sp.– Madimadla River bed, Gurtedu-Dharakonda.

Aristolochiaceae

Aristolochia tagala Cham.– Yarlagadda-Sesharayi.

A. indica Linn.– Palakonda ; Gunjugudem.

Piperaceae

Peperomia dindigulensis Miq.– Nulakamaddi-Ramavaram.

P. reflexa A. Dietr.—Saparlu, Gudem valley.

Piper attenuatum Buch.-Ham.– Ethakonda.

Myristicaceae

Knema attenuata Warb.– NE. slope of Dummakonda ; Dharakonda falls.

Lauraceae

Beilschmiedia fagifolia Nees—Rampa Hill.

Cinnamomum zeylanicum Bl.– Ethakonda.

Litsea glutinosa (Lour.) C. B. Robinson—Gudem Hill.

L. deccanensis Gamble—Ebul Reserve, north of Gudem Camp.

L. laeta Wall.– Rampa Hill.

L. ligustrina Trim. ex Hook. f.—Gurtedu-Dharakonda.

L. monopetala (Roxb.) Pers.—Gudem valley.

L. salicifolia (Roxb.) Hook. f.—Rampa Hill.

Machilus macrantha Nees—Mattambhimavaram-Gurtedu.

Neolitsea foliosa (Nees) Gamb. var. **caesia** Meissn.—Sesharayi ; Ethakonda ; Devarakonda.

Loranthaceae

Dendrophthoe falcata (Linn. f.) Etting.—Rampa Hill ; Sesharayi ; Chinaudasakarru ; Bulasipalem.

Scurrula philippensis (Cham. & Schlecht.) G. Don—Dorapalem, near Kota ; Kota.

Scurrula pulverulenta (Wall.) G. Don—Gurtedu-Dharakonda.
Viscum articulatum Burm. f.—Borragudem ; Ramavaram ; Addatigala.
V. capitellatum Sm.—Bulasipalem.
V. monoicum DC.— Malapeta, near Gudem.
V. orientale Willd.—Gokavaram-Chodavaram ; Ethakonda.

Santalaceae

Osyris wightiana Wall. ex Wight—Dummakonda.

Balanophoraceae

Balanophora dioica R. Br.—Sesharayi.
B. indica Wall.—Gudem valley.

Buxaceae

Sarcococca trinervia Wight—Gudem valley ; Nilavarampadu.

Euphorbiaceae

Acalypha alnifolia Klein ex Willd.—Near Rayapalli ; Ramavaram.
Alchornea mollis Muell.-Arg.—Ethakonda.
Antidesma diandrum Roth—Peddakonda ; Kota.
A. ghaesembilla Gaertn.—Ramavaram.
Baliospermum montanum (Willd.) Muell.-Arg.—Dharakonda ; Gangadevi ghat.
Bischofia javanica Bl.—Sesharayi ; Dummakonda.
Bridelia hamiltoniana Wall.—Rampa Hill ; Kota.
B. squamosa Gehrm.—Cheruvupalem.
B. stipularis Bl.—Dharakonda Hill slope.
B. tomentosa Bl.—Hills of Godavari Dist.
Chrozophora parvifolia Klotzch.—Godavari banks.
Cleistanthus collinus Benth.—Gokavaram-Chodavaram.
Euphorbia antiquorum Linn.—Rayapalli.
E. hirta Linn.—Rampa-Chodavaram ; Kota ; Addatigala.
E. parviflora Linn.—Kunjumveedi.
E. zornioides Boiss.—Dummakonda.
Emblica officinalis Gaertn.—Rampa Hill ; Marrivada ; Nilavarampadu.
Glochidion velutinum Wight—Dummakonda.
G. zeylanicum A. Juss.—Rampa Hill ; Peddakonda ; Komaravaram.
Homonoia riparia Lour.—Rampa-Chodavaram.
Jatropha curcas Linn.—Burugupalem.
J. gossypifolia Linn.—Kota.
Macaranga peltata (Roxb.) Muell.-Arg.—Yarlagadda.-Sesharayi ; south-east of Gudem Camp.
Mallotus philippensis Muell.-Arg.—Rayapalli; Rampa Hill ; Chodavaram ; Gunjugudem Hill ; Ramavaram.
Mallotus sp.—Rampa Hill.
Melanthesa rhamnoides (Retz.) Bl.—Rampa Hill; Gunjugudem.
Neopeltandra suberosa Gamb.—Hills in Godavari Dist.
Phyllanthus debilis Ham.—Palakonda ; Devarakonda ; Nulakamaddi.
P. maderaspatensis Linn.—Rampa Hill.

Phyllanthus narayanaswamii Gamb.—Dummakonda top.

P. simplex Retz.—Bhupathipalem ; Dummakonda.

P. urinaria Linn.—Rampa Hill; Yarlagadda-Sesharayi ; Gurtedu-Dharakonda.

Sauropus quadrangularis Muell.-Arg.—Nilavarampadu near Gudem.

Sebastiana chamaelea Muell.-Arg.—Nulakamaddi ; Rampa Hill.

Tragia involucrata Linn.—Rampa Hill.

T. involucrata Linn. var. **angustifolia** Hook. f.—Palakonda near Maredumalli.

Trewia polycarpa Benth.—Hills of Godavari Dist.

URTICACEAE

Artocarpus heterophyllus Lamk. ; Jarrett in Jour. Arnold Arb. **40** : 334, 1959—Sesharayi.

Boehmeria malabarica Wedd.—Malapalle near Gudem.

B. platyphylla Don—Palakonda.

B. sidaefolia Wedd.—SE. hill slope of Gudem Camp.

Celtis cinnamomea Lindl.—Rampa.

Elatostemma cuneatum Wight—Peddakonda.

Ficus arnottiana Miq.—Nulakamaddi-Komaravaram.

F. asperrima Roxb.—Gurtedu-Dharakonda.

F. hispida Linn. f.—Gunjugudem.

F. microcarpa Linn. f. ; Corner in Gard. Bull. **17** : 397, 1960—Sesharayi ; Yarlagadda-Sesharayi.

F. nervosa Heyne ex Roth—Rampa Hill.

F. oligodon Miq. ; Corner in Gard. Bull. **18** : 43, 1960—Rampa Hill.

F. rumphii Blume—Rampa Hill.

F. semicordata Buch.-Ham. ex Sm. ; Corner in Gard. Bull. **17** : 449, 1960—Yarlagadda-Sesharayi.

F. tinctoria Forst. f. subsp. **parasitica** (Willd.) Corner var. **parasitica** Corner l.c. 475-477, 1960—Yarlagadda-Sesharayi ; Komaravaram-Yarlagadda.

F. tomentosa Roxb. ex Willd.—Rayapalli.

Fleurya interrupta Gaud.—Sesharayi.

Laportea crenulata Gaud.—Rampa Hill.

Phyllochlamys spinosa Bureau—Sesharayi Hill.

Pouzolzia auriculata Wight—Devarakonda.

P. zeylanica Benn.—Sesharayi Hill top ; Rampa Hill.

P. pentandra Benn.—Dummakonda.

P. wightii Benn.—Palakonda.

Trema orientalis Blume—Chinaudasakarru ; Peddakonda.

SALICACEAE

Salix tetrasperma Roxb.—Chinaudasakarru.

ORCHIDACEAE

Acampe wightiana Lindl.—Kota.

Aerides multiflorum Roxb.—Yarlagadda-Sesharayi ; Sesharayi-Nulakamaddi.

A. odoratum Lour.—Sesharayi Hill.

Cleisostoma mannii Reichb. f.—Palakonda.

Cymbidium aloifolium Sw.—Komaravaram ; Gurtedu-Dharakonda ; Maredumalli.

Dendrobium aphyllum Fischer—Gudem valley.
D. aqueum Lindl.—Yarlagadda mutta.
Eria bambusifolia Lindl.—Gudem valley.
Habenaria hollandiana Santapau in Fl. Purandhar, 126, 1958—Rampa Hill.
H. digitata Lindl.—Dharakonda Hill slope.
H. ovalifolia Wight—Dummakonda.
H. plantaginea Lindl.—Rampa Hill ; Chintagondi.
Luisia teretifolia Gaud.—Gudem valley.
Nervilia aragoana Gaud.—Rampa Hill.
N. plicata Schltr.—Maredumalli.
N. crispata Schltr.—Devarakonda.
Oberonia brunoniana Wight—Near Sesharayi.
O. ensiformis (Sm. ex Rees) Lindl.—Gudem valley.
O. falconeri Hook. f.—Sesharayi.
O. iridifolia Lindl. var. **denticulata** Hook. f.—Rampa Hill.
O. wightiana Lindl.—Ethakonda ; Ebul Reserve, Gudem.
Peristylus plantagineus Lindl.—Maredumalli.
Pholidota pallida Lindl.—Gudem valley.
Saccolabium calceolare Lindl.—Ebul Reserve, Gudem.
S. curvifolium Lindl.—Ebul Reserve, Gudem.
S. ochraceum Lindl.—Ebul Reserve, Gudem.
Satyrium nepalense D. Don—Nilavarampadu.
Vanda parviflora Lindl.—Bhupathipalem.
V. tessellata Hook.—Koonavaram.
Vanda sp.—Yarlagadda-Sesharayi.

ZINGIBERACEAE

Costus speciosus Smith—Sesharayi ; Rampa Hill.
Curcuma aromatica Salisb.—Rampa Hill.
Curcuma sp.—Near Nulakamaddi.
Globba ophioglossa Wt.—Rampa Hill.
Hedychium coronarium Koenig—Nulakamaddi.
Zingiber roseum Rosc.—Dummakonda.
Z. casumunar Roxb.—Maredumalli.
Z. chrysanthum Rosc.—Dummakonda.

MARANTACEAE

Phrynium sp.—Gudem Hill slope.

MUSACEAE

Musa rosacea Jacq.—Sesharayi Hill ; Dummakonda ; Gudem valley.

AMARYLLIDACEAE

Curculigo orchioides Gaertn.—Rampa Hill.
C. recurvata Dryand.—Gudem valley.

TACCACEAE

Tacca pinnatifida Forst.—Borragudem.

Dioscoreaceae

Dioscorea wallichii Hook. f.—Yarlagadda-Sesharayi.
D. alata Linn.—Lanjivada near Geddada; near Chintapalli; Yarlagadda-Ethakonda.
D. anguina Roxb.—Sesharayi ; Yarlagadda-Sesharayi.
D. belophylla Voigt—Dummakonda.
D. bulbifera Linn.—Near Ramavaram.
D. glabra Roxb.—South-east of Gudem Camp.
D. oppositifolia Linn.—Gokavaram-Chodavaram ; Buggimetta ; Bhupathipalem ; on way to Gurtedu.
D. pentaphylla Linn.—Peddakonda ; near Nulakamaddi.
D. tomentosa Heyne—Gokavaram-Chodavaram.
Dioscorea sp.—Bhupathipalem.

Roxburghiaceae

Stemona tuberosa Lour.—Dummakonda slope.

Liliaceae

Asparagus racemosus Willd.—Peddakonda ; Ethakonda ; Sesharayi.
Chlorophytum arundinaceum Baker—Rampa Hill; Puttapalli.
C. orchidastrum Lindl.—Rampa Hill.
Cordyline roxburghiana (Schult. f.) Royen ex Adanson—Rampa Hill.
Disporum pullum Salisb.—Ethakonda ; Nulakamaddi ; Ramavaram.
Dracaena terniflora Roxb.—Ethakonda ; Yarlagadda-Sesharayi.
Gloriosa superba Linn.—Gokavaram ; Peddakonda.
Iphigenia indica (Linn.) A. Gray—Dummakonda.
Ophiopogon intermedius D. Don—Gudem valley.
Smilax zeylanica Linn.—Peddakonda ; Maredumalli metta.
S. prolifera Roxb.—Gudem valley.

Pontederiaceae

Monochoria vaginalis Presl.—Gaddada.
M. vaginalis Presl. var. **plantaginea** Solms.-Laub.—Nilavaram-Gudem.

Commelinaceae

Aneilema scaberrimum Kunth—Sesharayi.
Commelina benghalensis Linn.—Marrivada.
C. diffusa Burm.f.—Bhupathipalem.
C. kurzii C. B. Clarke—Rampa Hill ; Ethakonda ; Kondapudi ; Dharakonda ; Devarapalli.
C. longifolia Lamk.—Nulakamaddi ; near Nilavaram.
C. suffruticosa Bl.—Rampa Hill ; Devarapalli.
Cyanotis arachnoidea C. B. Clarke—Dummakonda ; Devarakonda.
C. axillaris (Linn.) R. & S.—Rampa Hill.
C. cristata (Linn.) Don—Rampa Hill ; Devarapalli ; Devarakonda.
C. cucullata Kunth—Rampa Hill.
C. fasciculata Schult. f.—Devarakonda.
Floscopa scandens Lour.—Sesharayi ; near Mattambhimavaram.
Murdannia nudiflora (Linn.) Brenan—Bhupathipalem.
M. spirata (Linn.) Brückn.—Near Nilavaram.
Pollia secundiflora (Bl.) Baker—Gudem valley ; Ethakonda.

FLAGELLARIACEAE

Flagellaria indica Linn.—Near Sesharayi stream.

ARECACEAE (=PALMACEAE)

Calamus latifolius Roxb.—Gudem valley.
C. viminalis Willd.—Near Sesharayi ; Nilavarampadu ; Gudem-Marripakalu
C. viminalis Willd. var. **fasciculatus** Becc.—Rampa Hill.
Caryota urens Linn.—Ethakonda ; Yarlagadda-Sesharayi.

ARACEAE

Alocasia decipiens Schott.—Peddakonda ; Rampa Hill. New record for India.
Amorphophallus bulbifer Bl.—Devarakonda.
A. chlorospathus Kurz—Rampa Hill.
Arisaema tortuosum Schott.—Dummakonda.
Colocasia esculenta (L.) Schott.—Sesharayi-Nulakamaddi.
Lasia spinosa (Linn.) Thw.—Near Saparlu, Gudem valley ; Peddakonda.
Plesmonium margaritiferum Schott.—Rampa Hill.
Remusatia vivipara Schott.—Maredumalli.
Rhaphidophora pertusa Schott.—Saparlu, Gudem valley.
Scindapsus officinalis Schott.—Rampa Hill.

ERIOCAULACEAE

Eriocaulon quinquangulare Linn.—Yarlagadda.
E. truncatum Ham.—Ramavaram-Sesharayi.

CYPERACEAE

Carex baccans Nees—Ethakonda ; Gudem valley.
C. myosurus Nees—Devarakonda ; Ebul Reserve, Gudem.
C. speciosa Kunth—Rampa Hill.
C. stramentita Boott.—Dummakonda top ; Gudem valley ; Ebul Reserve, Gudem. New record for peninsular India.
Cyperus aristatus Rottb.—Rampa Hill.
C. brevifolius (Rottb.) Hassk.—Rampa-Chodavaram ; Addakonda, Peddur-Kota.
C. compressus Linn.—Rampa Hill.
C. diffusus Vahl—Devarakonda ; south-east of Gudem Camp.
C. eleusinoides Kunth—Bhupathipalem.
C. exaltatus Retz.—Gudem valley.
C. niveus Retz.—Chodavaram.
C. pilosus Vahl—Rampa-Chodavaram.
C. pilosus Vahl var. **obliqua** C. B. Clarke—Rampa-Chodavaram.
Eleocharis capitata R.Br.—Nilavarampadu, near Gudem.
Fimbristylis dichotoma Vahl var. **pluristriata** (Cl.) Rolla Rao *comb. nov.*[1]—Kota.
F. monostachyos (L.) Hassk.—Buggimetta.
F. quinquangularis Kunth—Bhupathipalem.
Mariscus compactus Druce—Peddakonda.
Scleria corymbosa Roxb.—Sesharayi Hill slope.
S. hebecarpa Nees—Palakonda ; Yarlagadda-Sesharayi.

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[1] Basionym : *F. diphylla* Vahl v. *pluristriata* C. B. Clarke in FL. BR. IND. 6 : 631, 1893.

Poaceae (=Gramineae)

Alloteropsis cimicina (L.) Stapf—Rampa Hill.
Apluda mutica Linn.—Gudem valley ; Rampa-Chodavaram.
Apocopis courtallumensis (Steud.) Henr.—Devarakonda top.
Aristida setacea Retz.—Rampa Hill ; Rayapalli.
Arthraxon lancifolius (Trin.) Hochst.—Dummakonda.
Arundinella pumila (Hochst.) Steud.—Gudem valley.
A. setosa Trin.—Gudem valley.
Bambusa arundinacea (Retz.) Willd.—Rampa Hill.
Bothriochloa glabra (Roxb.) A.Camus—Rampa Hill.
B. intermedia (R.Br.) A.Camus var. **punctata** (Roxb.) Keng.—Devarakonda.
B. pertusa (L.) A. Camus—Chinaudasakarru.
Brachiaria kurzii (Hook. f.) A. Camus—Rampa Hill ; Ethakonda.
Capillipedium assimile (Steud.) A. Camus; Bor in GRASSES OF BURMA etc. 110 (1960) —Ebul Reserve, Gudem.
Centotheca lappacea (L.) Desv.—Gudem valley.
Chionachne koenigii (Spr.) Thw.—Gudem valley.
Chloris bournei Rang. et Tadu.—Godavari Dist.
C. dolichostachya Lagasca. (l.c) 466.—Devarakonda ; Gudem valley.
Coelachne pulchella R.Br.var. **simpliciuscula** (Wt. & Arn. ex Steud.) Hook.f.—Nilavarampadu.
Coix lachryma-jobi Linn.—Nulakamaddi ; Sesharayi-Nulakamaddi.
Chrysopogon aciculatus (Retz.) Trin.—Erragondi.
C. fulvus (Spreng.) Chiov. ; Bor (l.c.) 116.—Godavari Dist.
C. polyphyllus (Hack.) Blatt. & McCann—Godavari Dist.
C. verticillatus (Roxb.) Trin.ex Steud.—Palakonda ; Kappakonda.
Cymbopogon coloratus (Nees) Stapf—Palakonda ; Devarakonda.
C. nardus (L.) Rendle—Maredumalli.
C. nardus (L.) Rendle var. **confertiflorus** (Steud.) Stapf ex Bor—Rampa Hill.
Cynodon dactylon (L.) Pers.—Devarapalli.
Cyrtococcum oxyphyllum (Steud.) Stapf—Ethakonda ; on way to Dummakonda ; Nilavarampadu.
C. trigonum (Retz.) A.Camus—Gudem valley.
Dactyloctenium aegyptium (L.) Beauv.—Devarapalli.
Dendrocalamus strictus Nees—Rampa Hill ; Maredumalli metta ; near Komaravaram.
Dicanthium annulatum (Forsk.) Stapf—Chinaudasakarru.
Digitaria adscendens (HBK) Henr.—Godavari Dist.
D. granularis (Trin.) Henr.—Buggimetta.
D. sanguinalis (Linn.) Scop.—Borragudem.
D. tomentosa (Koen.) Henr.—Rampa Hill.
Dinebra retroflexa (Vahl) Panz.—Godavari Dist.
Echinochloa colonum (L.) Link.—Rampa Hill.
E. frumentacea Link.—Foot of Rampa Hill ; Rampa-Chodavaram.
Eleusine coracana (Linn.) Gaertn.—Foot of Rampa Hill ; Sesharayi-Guramanda.
Eragrostiella bifaria (Vahl) Bor—Rampa Hill.
Eragrostis ciliata (Roxb.) Nees—Bhupathipalem ; Talapalem ; near Chidipalem.
E. deccanensis Bor—Godavari Dist.
E. gangetica (Roxb.) Steud.—Gudem valley.
E. japonica (Thunb.) Trin.—Godavari Dist.
E. tremula Hochst.—Godavari Dist.

Eragrostis unioloides (Retz.) Nees ex Steud.—Bhupathipalem ; Rayapalli ; Yarlagadda ; Sesharayi ; near Nulakamaddi.

E. viscosa (Retz.) Trin.—Chinaudasakarru ; near Chidipalem.

Eulalia phaeothrix (Hack.) O.Kuntze—Dummakonda.

E. wightii (Hook.f.) Bor —Dummakonda.

Eulaliopsis binata (Retz.) Hubb.—Godavari Dist.

Hackelochloa granularis (L.) O. Kuntze—Bhupathipalem.

Haemarthria compressa (Linn.) R.Br.—Godavari Dist.

Heteropogon contortus (Linn.) Beauv.—Rampa-Chodavaram ; Ethakonda ; north-west slope of Dharakonda.

Imperata cylindrica (L.) Beauv.—Puttapalli ; near Nulakamaddi.

Isachne dispar Trin.—Nilavarampadu, near Gudem Camp.

I. miliacea Roth—Kota.

Iseilema prostratum (Linn.) Anders.—Gudem valley.

Leptochloa neesii (Thw.) Benth.—Godavari Dist.

L. panicea (Retz.) Ohwi—Godavari Dist.

Microchloa indica (Linn.f.) P.Beauv.—Godavari Dist.

Microstegium ciliatum (Trin.) A.Camus—SE. of Gudem Camp.

Oplismenus compositus (Linn.) P.Beauv.—Chintagondi Hill ; Ethakonda ; near Nulakamaddi ; south-east of Gudem Camp.

O. granulatus Nees et Arn.—Devarakonda ; Ethakonda ; Dharakonda Hill slope.

Panicum brevifolium Linn.—Yarlagadda-Sesharayi ; near Sesharayi ; near Nulakamaddi.

P. montanum Roxb.—Devarakonda.

P. psilopodium Trin.—Bhupathipalem.

Paspalidium flavidum (Retz.) A.Camus—Rampa Hill.

Paspalum scrobiculatum Linn.—Geddada.

Pennisetum hohenackeri Hochst. ex Steud.—Gudem valley.

P. pedicellatum Trin.—Godavari Dist.

P. typhoides (Burm.) Stapf et Hubb.—Foot of Rampa Hill.

Pogonatherum paniceum (Lamk.) Hack.—Godavari Dist.

Pseudanthistiria umbellata (Hack.) Hook. f.—Godavari Dist.

Pseudosorghum fasciculare (Roxb.) A.Camus—Godavari Dist.

Rottboellia exaltata Linn. f.—Borragudem.

Saccharum spontaneum Linn.—Kota ; Peddakonda ; near Yarlagadda.

Setaria glauca (Linn.) P.Beauv.—Rampa Hill.

S. italica (Linn.) P.Beauv.—Borragudem.

S. palmifolia (Koen.) Stapf—Gangadevi ghat ; Gudem-Marripakalu.

S. tomentosa (Roxb.) Kunth—Rampa Hill.

S. verticillata (Linn.) P.Beauv.—Gunjugudem.

Sorghum halepense (Linn.) Pers.—Erragondi ; Peddakonda.

Sporobolus maderaspatanus Bor—Godavari Dist.

Themeda laxa (Ander.) A.Camus—Palakonda.

T. tremula (Nees) Hack.—Chinaudasakarru ; Ebul Reserve, Gudem.

T. triandra Forsk.—Rayapalli ; Chinaudasakarru ; Ebul Reserve, Gudem.

Thysanolaena maxima (Roxb.) O. Kuntze—Rampa Hill ; Ethakonda ; Yarlagadda-Sesharayi.

Tragus biflorus Schult.—Chodavaram.

GYMNOSPERMS

Gnetaceae

Gnetum ula Brogn.—Yarlagadda ; Dummakonda ; Dharakonda ; Gudem valley.

PTERIDOPHYTES

Classification and nomenclature after R. E. Holttum, FLORA OF MALAYA (II FERNS), 1958.

Ophioglossaceae

Botrychium daucifolium Wall.—Gudem valley.

Marattiaceae

Angiopteris evecta (Forst.) Hoffm.—Ethakonda ; south-east of Gudem Camp.

Schizaeaceae

Lygodium flexuosum (L.) Sw.—Rampa Hill ; Ethakonda ; NE. of Sesharayi Hill ; near Nulakamaddi.

Gleicheniaceae

Dicranopteris linearis (Burm.) Underw.—Gudem valley.

Hymenophyllaceae

Crepidomanes bipunctatum (Poir.) Copel.—Ethakonda.

Cyatheaceae

Cyathea gigantea (Wall.) Holtt.—Gudem valley ; Gangadevi ghat.
C. latebrosa (Wall.) Copel.—Gangadevi ghat ; Gudem-Marripakalu.
C. spinulosa Wall.—Ethakonda ; Gudem valley.

Polypodiaceae

Drynaria quercifolia (L.) J.Sm.—Devarakonda.
Leptochilus decurrens Bl.—SE. of Gudem Camp ; Ethakonda.
Pyrrosia adnascens (Forst.) Ching—Yarlagadda-Sesharayi.

Thelypteridaceae

Abacopteris multilineata (Wall.) Ching—Rampa Hill.
A. urophylla (Wall.) Ching—Yarlagadda-Sesharayi; Sesharayi Hill ; Ethakonda.

DENNSTAETIACEAE

Odontosoria chinensis (L.) J.Sm.—Gudem valley.
Nephrolepis cordifolia (L.) Pr.—Sesharayi Hill.
N. exaltata Presl.—Sesharayi.
N. hirsutula Presl.—Ethakonda.
Pteris biaurita Linn.—Gudem valley.
P. pellucida Presl.—Rampa Hill ; Ethakonda.
P. quadriaurita Retz. var. **argentea** Bedd.—Ethakonda.
Stenochlaena palustris (Burm.) Bedd.—Rampa Hill.
Asplenium formosum Willd.—Ethakonda ; SE. of Gudem Camp.
A. laciniatum Don—SE. of Gudem Camp.
A. lunulatum Sw.—SE. of Gudem Camp.
Blechnum orientale Linn.—Gudem valley.
Dryopteris cochleata (Don) C.Chr.—Gudem valley ; Maredumalli.
D. parasitica (L.) O. Kuntze—Foot of Rampa Hill ; Ethakonda.
D. otaria O. Kuntze—Maredumalli Forest.
Tectaria macrodonta (Fee) C.Chr.—Top of Dummakonda.
Athyrium asperum (Bl.) Milde.—Ethakonda ; SE. of Gudem Camp.
A. esculentum (Retz.) Copel.—Kota.

ADIANTACEAE

Adiantum incisum Forskal—Rampa Hill.
A. philippense L.—Rampa Hill slope ; Maredumalli ; near Nulakamaddi.
Cheilanthes farinosa (Forsk.) Klf.—Gudem valley.
C. tenuifolia Sw.—Rampa Hill.
Hemionites arifolia (Burm.) Moore—Maredumalli ; Sesharayi ; Yarlagadda-Sesharayi ; near Nulakamaddi.

LYCOPODIACEAE

Lycopodium cernuum Linn.—Gudem valley.

SELAGINELLACEAE

Selaginella barbata Spreng.—Rampa Hill ; Dummakonda.

Studies on the Biology of some Freshwater Fishes

PART II—*Barbus stigma* (Cuv. & Val.)

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(*With eight figures*)

[*Continued from Vol.* **61** (1) : 98]

INTRODUCTION

Barbus stigma (Cuv. & Val.) is another very common fish of India. It is found all over the country and has also been reported from Burma (Day 1878). It occurs in all types of fresh water and becomes very abundant during the monsoon months when most of the low-lying areas get flooded. In summer, when the water in ponds gets considerably receded, it is caught in large numbers by employing various indigenous methods which vary from place to place. Generally the fish is scooped up with a lift net or an ordinary cloth or by using locally-made baskets. The maximum size which this fish attains is about 13 cm.

So far no proper investigation has been carried out on the biology of this species. A survey of the past literature shows only brief comments on its breeding and food (Raj 1916; Sen 1937, 1954; Mookerjee *et al.* 1941; Chacko & Kuriyan 1948; Das & Moitra 1955, 1956a; Sathyanesan 1960, 1961).

METHODS

Fishes were caught from ponds at monthly intervals between February 1959 and March 1960 by using cast nets. In winter and

summer months after the water in ponds has decreased considerably, it is possible to obtain about 50 fish from one pond alone with one or two operations of the cast net. During monsoon months, when the ponds get flooded, the operation of the cast net becomes a little difficult and therefore for obtaining a sample ponds had to be selected

TABLE VIII

NUMBER OF FISH (*B. stigma*) OF EACH LENGTH GROUP CAUGHT IN VARIOUS MONTHS

Length group	February	March	April	May	June	July	August	September	October	November	December	January	February	March
cm.														
3.5	3	5	..	..	..	..	..	..	5	13	2	3	..	..
4.0	2	12	..	..	..	..	..	..	..	10	5	2	..	..
4.5	5	8	2	..	..	..	..	..	..	5	7	1	..	..
5.0	6	1	3	..	..	..	..	..	..	3	5	5	..	..
5.5	..	..	4	..	1	1	..	..	..	..	1	1	..	..
6.0	..	1	2	1	..	2	4	..	..	..	2	1	..	..
6.5	6	6	6	2	1	1	..	..	5	4	3	..	4	2
7.0	9	5	3	1	..	2	..	..	..	4	2	..	5	..
7.5	4	4	7	4	..	2	..	3	1	6	..	..	1	..
8.0	1	8	18	4	4	3	4	7	6	..	..	10	11	8
8.5	1	3	..	3	7	14	16	6	8	1	2	4	13	2
9.0	1	11	..	..	13	17	16	6	4	2	7	7	2	1
9.5	3	2	2	6	2	10	2	7	5	4	2	7	11	2
10.0	2	..	2	4	5	2	5	..	2	4	3	3	1	5
10.5	..	..	2	6	2	1	1	..	1	..	1	1	1	..
11.0	..	1	..	5	..	1	..	..	..	..	1	..	..	..
11.5	..	..	..	..	2	4	..	..	..	..	1	..	..	4
12.0	..	..	..	..	..	3	..	..	..	..	..	..	..	..
12.5	1	..	..	..	1	..	..	..	..	..	..	..	..	..
13.0	..	..	..	..	..	1	..	..	..	..	..	..	..	..
Totals ..	44	67	51	36	38	64	48	29	37	56	44	45	4 9	24

which contained relatively less water. Even in these ponds, several attempts were required to obtain each month's sample. Since the samples could not be obtained regularly from a definite area it was not possible to maintain proper records of the locality. Monthly samples, therefore, used for the present investigation include fishes from different localities.

Fishes were measured to the nearest 0.5 cm. below and weighed accurately on a sensitive balance. Other techniques of routine examination were the same as those used for *Ophicephalus punctatus* (Part I).

Length frequency distribution

Table VIII shows the various size groups caught in each month. As the monthly histograms did not reveal any evidence of various year classes, the data, have been grouped into four quarters, each of three months, as was done with *O. punctatus.* These have been shown in Fig. 9. It can be seen from the figure that, although there is a considerable overlap in size, the first three year classes can be distinguished arbitrarily. The breeding season of the fish being June to September (Qasim & Qayyum 1961), the clearly marked mode at 4.5 cm. in the October to December histogram probably represents 0-group fishes. The next age group (year class I) can also be interpreted by another mode at about 6.7 cm. The larger-sized fishes in these months stand out in the form of a flattened curve. As there is no further discrimination of any other year class, all the fishes under this mode have been kept as year class II. As can be judged by the histogram, the average size of this year class is 9.2 cm.

A progression of these three modes in the following season, January to March, can also be traced. The 0-group fishes in these months have their average size at 4.8 cm. and the other two year classes at 7.1 cm. and 9.7 cm. respectively. During April to June, due to lack of smaller fishes in the sample, a clear peak of the 0-group fishes could not be obtained. However, in the histogram at 5.7 cm. there appears to be a small mode probably representing this group. Other year classes (I & II) can be seen at 8.0 and 10.2 cm. respectively in this season. The size-frequency distribution of the last quarter, July to September, clearly indicates three modes representing the three year classes (0, I, & II) at 6.2, 9.0, and 11.7 cm. respectively.

Within the limits of available data, by taking the average size of each mode from season to season (Table IX), it can be concluded that

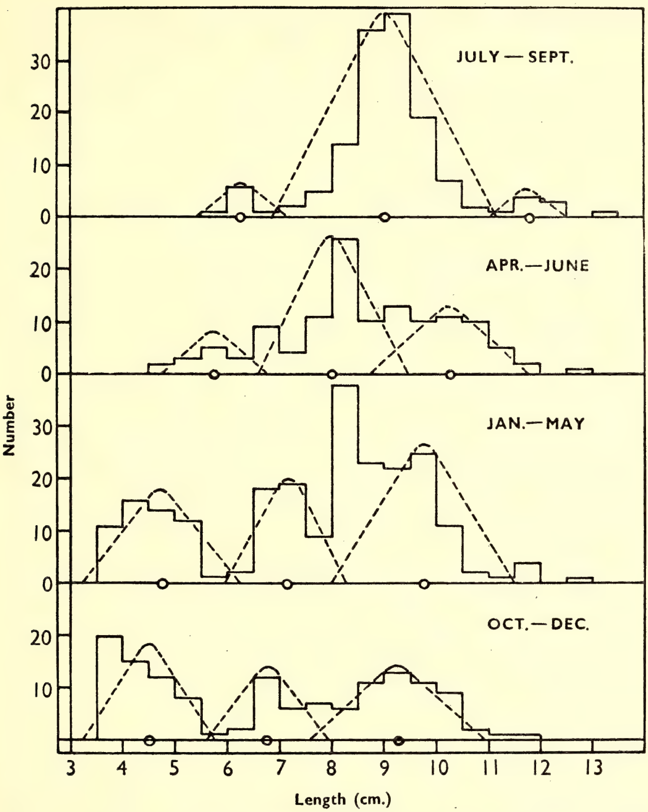

FIG. 9. Length frequency distribution of *B. stigma*

Open circles denote average lengths of various size groups as represented by modes. Possible modes marked by broken lines in each histogram.

all the three year classes continue to grow throughout the year. There appears to be no significant difference in growth during various seasons.

TABLE IX

AVERAGE LENGTH OF VARIOUS YEAR CLASSES OF *B. stigma* OBTAINED FROM THE LENGTH FREQUENCY DISTRIBUTION OF VARIOUS QUARTERS TOGETHER WITH THE SIZE RANGE OF EACH YEAR CLASS

Year Classes	Months	Range in size, cm.	Average length, cm
0	October-December	3.3-5.7	4.5
	January-March	3.3-6.3	4.8
	April-June	4.8-6.7	5.7
	July-September	5.4-7.1	6.2
I	October-December	5.6-7.9	6.7
	January-March	6.0-8.3	7.1
	April-June	6.6-9.4	8.0
	July-September	6.9-11.1	9.0
II	October-December	7.6-10.9	9.2
	January-March	8.0-11.5	9.7
	April-June	8.7-11.8	10.2
	July-September	11.0-12.5	11.7

BREEDING

(*a*) *Stages of maturity*

The gonads of *B. stigma* were classified according to their size, colour, and shape into five maturity stages as follows: (I) immature (ovaries light pink, translucent, and elongated; testes white and thread-like); (II) maturing virgins or recovered spents (ovaries elongated, eggs minute and visible to naked eye; testes white and enlarged); (III) ripening (ovaries light yellow, slightly lobed, eggs quite distinct; testes white, opaque, and thickened in girth); (IV) ripe (ovaries light yellow, greatly enlarged, lobed, and having a thin fragile wall which is easily ruptured during their removal; testes white, enlarged, and thickened); (V) spent (ovaries shrunken with a few residual eggs; testes shrunken, whitish grey in colour).

(*b*) *Size at first maturity*

Table X gives the total number of each sex at various maturity stages. It is evident from the table that all fishes up to 5 cm. belonged to the immature class (stage I). In 6 cm. group, both sexes though mostly immature begin to show higher stages of maturity also (stages II and III). In females in this size group no further advance in maturity is seen beyond stage III. The smallest ripe male was of 6.6 cm. in length and the smallest females where both ripe and spent stages were seen were of 7.2 and 7.1 cm. respectively. It, therefore, appears that males mature at a relatively smaller size. Both sexes seem to

TABLE X

MATURITY STAGES IN VARIOUS LENGTH GROUPS OF *B. stigma*

Maturity stages		Length in cm. → 3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0
MALE	I.	12	31	12	13	..	..	..	..	..	..	..
	II.	..	..	..	10	14	64	8	3	..	..	..
	III.	..	..	..	3	3	5	6	1	..	..	..
	IV.	..	..	..	2	6	10	16	2	..	..	..
	V.	..	..	..	..	7	17	4	1	..	..	..
FEMALE	I.	19	28	19	23	1	..	..	..	..	..	..
	II.	..	..	..	1	25	25	44	18	4	1	..
	III.	..	..	..	1	5	5	9	9	4	..	..
	IV.	..	..	..	..	2	21	15	11	6	2	1
	V.	..	..	..	..	..	17	50	9	5	2	..

mature after they have completed one year of life (see length-frequency histograms).

(*c*) *Sex ratio*

The total number of fishes sexed was 632. Of these, 250 were males and 382 were females. It shows that the ratio between male and female in the population as a whole is 1 : 1.5. The sex ratio of different size groups captured is shown in Table X. It can be seen from the table that up to 7 cm. length group both sexes are evenly distributed in the population. At 8 cm. the males outnumber the females, the ratio being 1 : 0.7. In size groups higher than 8 cm. the females are in the majority. At 9 cm. the ratio of female to male is 1 : 0.29. The largest male captured was of 10.6 cm. whereas the largest female was of 13.4 cm. This indicates that the males are shorter lived or probably they have a slower growth rate.

(*d*) *Spawning cycle*

As has been noted earlier, the samples obtained in each month

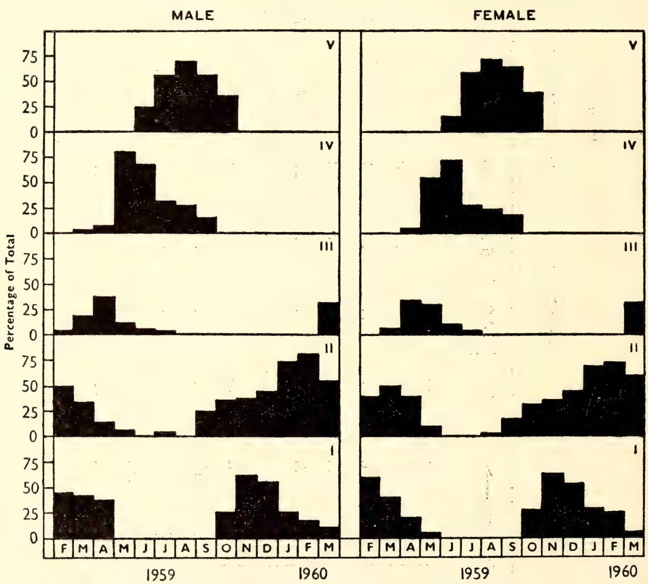

FIG. 10. Monthly percentages of *B. stigma* at each of the five maturity stages

included fishes from different localities. It was therefore not possible

to make specific records of spawning cycles in various ponds. However, during observations it was noticed that spawning in different ponds is non-synchronous. It may occur earlier in some and later in others. Therefore, the picture of the spawning cycle presented here

TABLE XI

NUMBER OF FISH (*B. stigma*) AT EACH OF THE FIVE MATURITY STAGES IN EACH MONTH

Month	Sex	Maturity Stages					Total
		I	II	III	IV	V	
February	Male Female	11 12	12 8	1 ..	.. ..	.. ..	24 20
March	Male Female	11 17	9 21	5 3	1 ..	.. ..	26 41
April	Male Female	5 7	2 15	5 14	1 2	.. ..	13 38
May	Male Female	.. 1	1 2	2 6	13 11	.. ..	16 20
June	Male Female	.. ..	.. ..	1 3	9 19	2 4	12 26
July	Male Female	.. ..	1 ..	1 2	7 13	9 31	18 46
August	Male Female	.. ..	.. 1	.. ..	2 10	5 30	7 41
September	Male Female	.. ..	3 3	.. ..	3 3	6 11	12 17
October	Male Female	5 5	7 6	.. ..	.. ..	7 7	19 18
November	Male Female	15 19	11 11	.. ..	.. ..	.. ..	26 30
December	Male Female	9 16	6 13	.. ..	.. ..	.. ..	15 29
January	Male Female	5 8	14 18	.. ..	.. ..	.. ..	19 26
February	Male Female	6 4	28 11	.. ..	.. ..	.. ..	34 15
March	Male Female	1 1	5 9	3 5	.. ..	.. ..	9 15
Total	Male Female	68 90	99 118	18 33	36 58	29 83	250 382

depicts the cycle of seasonal changes in gonads of the species from ponds in general. A reference to this feature has been made earlier (Qasim & Qayyum 1961).

The numbers of various maturity stages in different months are given in Table XI and their percentages have been plotted diagrammatically in Fig. 10. It is evident from the figure that both sexes reach maturing stage in December and January. In February the gonads of both sexes become considerably enlarged and reach the ripening stage. In March the testes become opaque and the ovaries become slightly lobed. In April ripe fishes begin to appear and in May and June, when both sexes become ripe, a marked change in the general appearance of gonads occurs. Ovaries become fully distended and fill almost the entire body cavity. A slight pressure over the abdominal region exudes the eggs. Ripe males have considerably enlarged testes which are thickened in girth. From June spent fishes of both sexes begin to appear and their maximum number is recorded in July. From August onward there is a progressive decline in the number of spent fishes and in November the gonads attain full recovery (stage II). From the cycle of maturation and depletion of gonads presented here it appears that the breeding season in *B. stigma* lasts for about four months, June to September. This is true when fishes from all types of localities are taken into account collectively. If breeding in an individual pond is considered separately, the spawning once started does not seem to extend for more than two months.

(*e*) *Seasonal changes in gonad weight*

The mean gonad weight and body weight ratio obtained in each month is plotted in Fig. 11. It is clear from the figure that there is a regular seasonal cycle in gonad weight. From March onwards both testes and ovaries begin to increase in weight. The testes reach their maximum in May which is earlier than the corresponding weight obtained for the ovaries. This probably signifies an early maturity in males. From July onwards the ratio in both sexes begins to fall and records its minimum in October. From November onwards there is a slow recovery in weight and it is not until February that a substantial increase in weight is noticed. The seasonal cycle in gonad weight clearly suggests that the fish reaches peak maturity in June and the spawning begins from late June or early July and continues till about September.

The breeding season of this species as given by earlier authors seems to differ from that observed at Aligarh. Thus, according to Sathyanesan (1960, 1961) the fish breeds from late April to July at

Benaras, while in Bengal Mookerjee *et al.* (1941) have given the breeding season from April to June. Mookerjee (1945a) has also made a

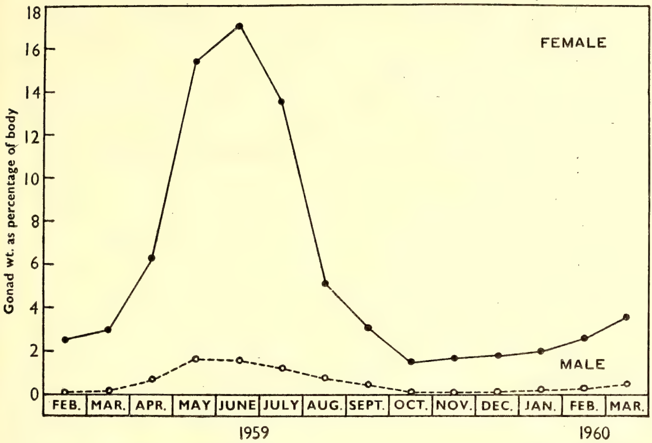

FIG. 11. Seasonal variation in the gonad weight as percentage of body weight of *B. stigma*

reference on its breeding in captivity. He states that, if this fish is given access to continuously changing rain-water, it spawns in small earthen pots.

(f) Spawning periodicity

The ova-diameter frequency of this species has been given elsewhere (Qasim & Qayyum 1961). The ovaries contain a single group of eggs suggesting that each individual spawns only once during the breeding season. This was confirmed by studying the spawning periodicity of the fish. The ova-diameter measurements from March to July have been shown in Fig. 12. This figure indicates the progression of a single batch of ova in the ovaries. In March when the fishes reach ripening stage, the average size of ova is about 0.35 mm. In April and May the ova which are likely to be spawned become clearly differentiated from the immature ones. In June the entire egg mass becomes separated from the yolkless cells. Spent fishes which begin to appear from July onwards show only the immature ova. This suggests that the entire egg mass is withdrawn from the ovary and that there is no spawning periodicity such as has been described in *O. punctatus* (Part I). Probably some residual eggs which remain in the ovaries are soon absorbed in the body.

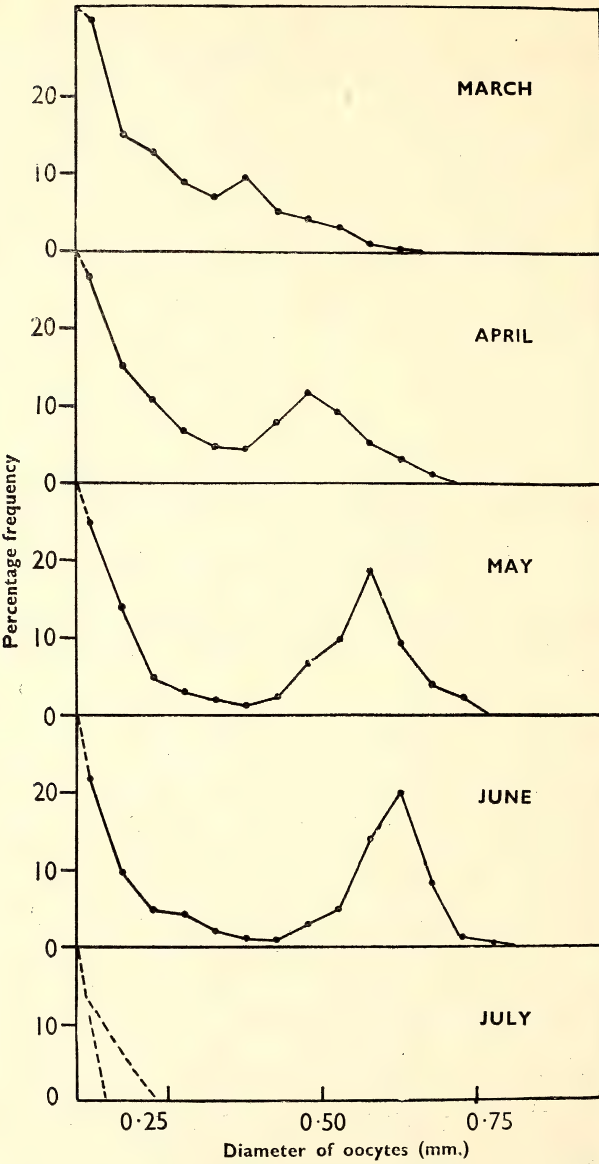

FIG. 12. Size frequency distribution of maturing oocytes of *B. stigma* from March to July

(*g*) *Condition-factor*

The 'condition-factor' of each specimen was calculated from the formula $K = \frac{W \times 100}{L^3}$. Fig. 13 shows the mean K values at different lengths for both sexes. As can be seen from the figure the K values

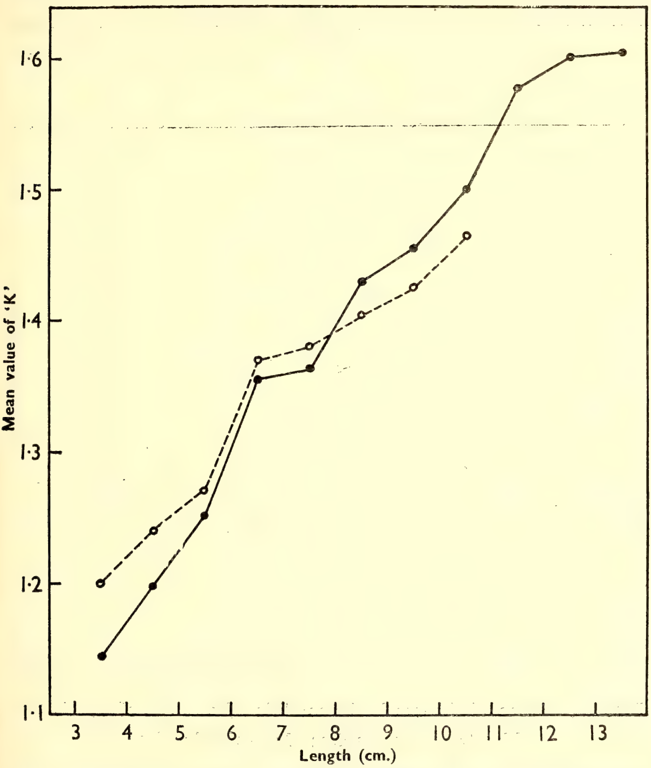

FIG. 13. Mean condition-factor (K) at different lengths of *B. stigma*
Of females, continuous line ; of males, broken line

increase steadily up to 6.5 cm. Thereafter the increase is relatively less. Such a change in the slope of the curve may be due to the onset of maturity. There is, however, no secondary fall in the condition-factor of large-sized fishes as has been found in *O. punctatus* (Part I).

Monthly variations in the condition-factor of the fish have been given in Fig. 14. A comparison of the cycle of condition-factor with that of the seasonal changes in the gonad-weight (Fig. 11) would reveal that the condition-factor of the fish is directly connected with the increase and decrease of gonad-weight. Since the changes in gonad-weight are never large in males, the cycle in the condition-factor in males is not as clearly defined as in females, where fishes with ripe gonads may weigh considerably more than the males in a

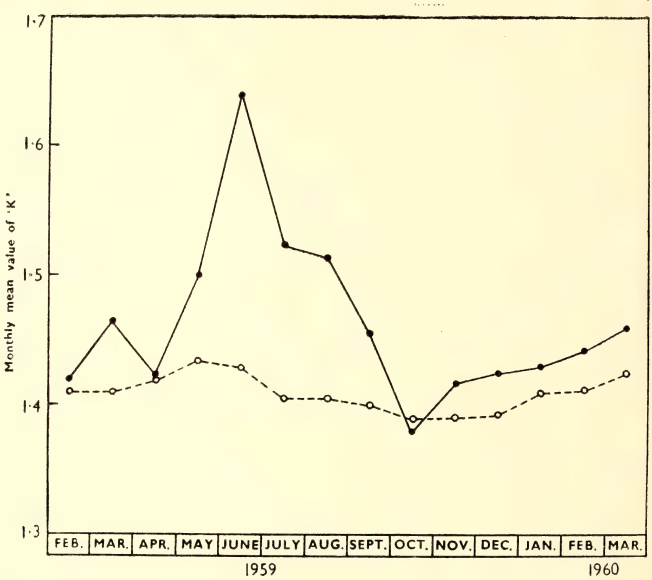

FIG. 14. Seasonal changes in the condition-factor (K) of *B. stigma*
Of females, continuous line ; of males, broken line

similar state of maturity. The females with high condition-factor are obtained in May, June, and July, whereas fishes with poorest condition-factor are found from October to February. Similar pattern is reflected from the condition-factor of males too. However, in females low condition-factor was also obtained in April 1959. This may have arisen because of greater preponderance of such individuals which came from poor environmental conditions.

TABLE XII

PERCENTAGE OCCURRENCE OF VARIOUS CATEGORIES OF FOOD IN THE GUTS OF *B. stigma*

Months⟶	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
No. of fish examined ..	44	67	51	36	38	64	48	29	37	56	44	45	49	24
No. of fish with food ..	43	65	50	36	38	64	47	29	36	53	41	42	47	23
Diatoms and desmids ..	79.5	78.7	84.0	61.0	86.8	84.3	80.8	100.0	83.3	79.2	92.6	73.8	53.1	69.5
Filamentous algae ..	15.9	30.3	50.0	33.3	21.0	23.4	19.1	3.4	9.4	1.8	14.6	16.6	27.6	34.7
Green algae ..	9.0	3.0	10.0	13.8	5.2	100.0	100.0	100.0	83.3	3.7	12.1	21.4	10.5	17.2
Higher aquatic plants ..	25.0	25.7	32.0	16.6	31.5	15.6	27.6	24.1	36.1	7.5	2.4	9.5	17.0	4.3
Copepods ..	11.3	6.1	8.0	75.0	28.9	32.8	10.6	27.5	19.4	26.4	19.5	14.2	34.0	69.5
Daphnids ..	9.1	1.5	4.0	11.1	5.2	9.3	4.2	3.4	9.4	11.3	9.7	50.0	2.1	8.6
Cypris ..	..	..	..	..	..	..	..	6.8	..	..	..	..	..	..
Dipteran larvae ..	45.4	57.5	12.0	22.2	5.2	3.1	..	3.4	2.6	1.8	12.1	16.6	82.9	
Rotifers ..	4.5	13.6	20.0	11.1	7.8	4.6	2.1	6.8	2.6	5.6	4.8	2.3	6.3	8.6
Debris, sand and mud ..	59.0	84.8	96.0	100.0	89.0	90.0	82.9	86.2	86.1	86.7	3.1	95.2	34.0	78.2

Food

Many references are available on the food of *B. stigma.* Earlier authors thought that the food of this fish consists of mosquito larvae, and for this reason they believed that, this fish could be used in mosquito control (Sewell & Choudhri 1912; Wilson 1917; Raj 1930; Chaterjee 1934; Prasad & Hora 1936; Hora & Mukerjee 1938; Job 1943, 1944). Recent observations of several workers indicate that *B. stigma* is largely herbivorous and, therefore, cannot be of much use as a larvicide (Sen 1937, 1954; Mookerjee *et al.* 1946b). The chief food as noted by Chacko & Kuriyan (1948) includes algae, higher aquatic plants, copepods, insect larvae, and rotifers. Das & Moitra (1955, 1956a, 1956b) after observing a variety of organisms in the gut concluded that the fish is omnivorous. This was further confirmed by Moitra (1956).

(*a*) *Food of all size groups*

The present study on the food gives a comprehensive account of the qualitative and quantitative analysis of food for a period of 14 months. The method of analysis of gut contents was the same as used for *O. punctatus* (Part I). In all 632 guts were examined during the period of investigation, only 18 of which were found to be empty. Table XII shows the percentage composition of various categories of food in each month. It is evident from the table that the major part of food consists of organic debris, algae, higher aquatic plants, cyclops, daphnids, and dipteran larvae. The occurrence of organic debris, sand, and mud in large quantities throughout the year indicates that the fish is a bottom feeder and, therefore, cannot be used as a larvicide.

The percentages of nine principal items of food in each month have been illustrated in Fig. 15. The total occurrence of these items in the total number of guts examined throughout the period of investigation is as follows:

1.	diatoms and desmids	... 79.0%
2.	filamentous algae	... 22.2%
3.	green algae	... 34.6%
4.	higher aquatic plants	... 19.6%
5.	cyclops	... 27.4%
6.	daphnids	... 9.2%
7.	dipteran larvae	... 23.6%
8.	rotifers	... 7.2%
9.	organic debris, sand, and mud	... 81.5%

Diatoms and Desmids: Diatoms comprising *Navicula, Nitzschia, Synedra, Cyclotella, Fragillaria, Melosira,* and *Amphora* were generally found in the guts. They occurred abundantly throughout the year.

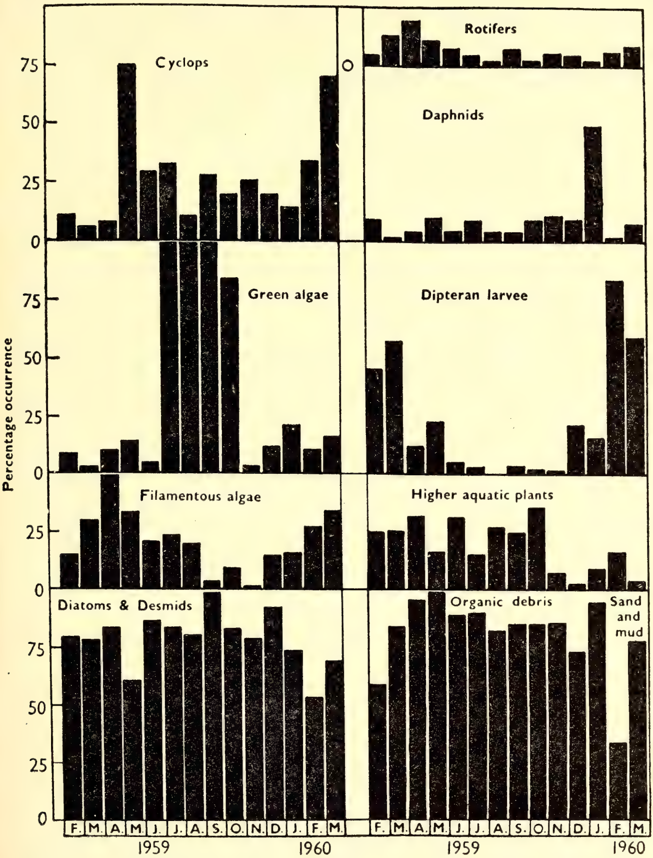

FIG. 15. Monthly variations in the composition of nine principal items of food of *B. stigma*

Navicula, Synedra, and *Fragillaria* were more common than *Nitzschia, Amphora,* and *Melosira.* Desmids were represented by two genera, *Closterium* and *Cosmarium.* These organisms, though quite frequent, were only seen in small quantities.

Filamentous algae: Spirogyra, Oscillatoria, Spirulina, Ulothrix, and *Anabaena* were found in nearly 22.2% guts. *Spirogyra* was the main constituent of this group and occurred abundantly in the guts from January to May. *Oscillatoria* was also recorded quite often. Other filamentous algae (*Spirulina, Ulothrix,* and *Anabaena*) were rare.

Green algae: These constituted *Volvox, Westella, Scenedesmus, Crucigenia, Ankistrodesmus,* and *Pediastrum.* *Volvox* formed an important item during the monsoon and post-monsoon months (July-October). Practically all the guts contained large quantities of *Volvox* in these months. From November onwards it became rare. *Scenedesmus,* though fewer in number, was of consistent occurrence throughout the year. *Westella* was also quite frequent. *Crucigenia, Pediastrum,* and *Ankistrodesmus* though present throughout the year were negligible in quantity excepting in July and August when *Ankistrodesmus* became abundant.

Higher aquatic plants: The occurrence of leaves and stem of *Vallisneria* and *Hydrilla* was in 19.6% of the total guts examined. With little fluctuations in their occurrence these plants were found in all months of the year.

Cyclops: These organisms were recorded in 27.4% guts. In May 1959 and March 1960 their occurrence was relatively higher than usual.

Daphnids: These occurred in 9.2% of the total guts examined and were found in all the months. In January 1959 nearly 50% of the guts contained these organisms.

Dipteran larvae: Mostly chironomid larvae were found in the gut. In February and March a large percentage of guts contained these organisms.

Rotifers: These organisms occurred nearly in 7.2% of the total number of guts examined.

Organic debris, sand, and mud: Decaying organic debris, sand, and mud were found in large quantities in the guts. These substances were predominant and occurred throughout the year (Fig. 15).

(*b*) *Seasonal variation in the rate of feeding*

Monthly values of the total weight of food obtained have been plotted in Fig. 16 as percentages of body weight. The same figure also gives the percentage of empty guts in each month. It is evident from the figure that the fish feeds actively throughout the year. Maximum quantity of food is consumed in May, June, and July when most of the fishes have ripe gonads. There occurs a slight decrease

in the feeding rhythm during October, November, and December when gonads are in a state of recovery. Moreover, in January and February, when the water temperature in ponds reaches its lowest, feeding begins to increase. Such a feeding rhythm in *B. stigma* is

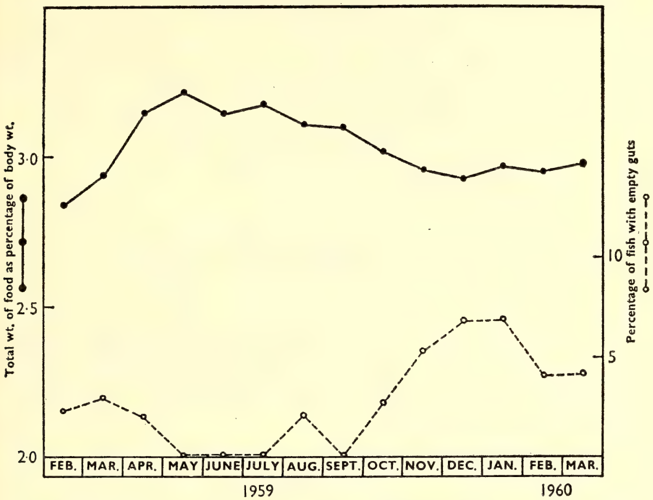

FIG. 16. Seasonal variation in the rate of feeding of *B. stigma*

Total weight of food as percentage of body weight, continuous line; percentage of empty guts, broken line

rather unusual as many teleosts are known to have reduced feeding during peak maturity, followed by intensive feeding after spawning. Low temperature conditions during winter months also lead to reduced food intake as has been shown in many other species including major carps (Vashist 1960). That in *B. stigma* ripe gonads and low temperature conditions do not affect the feeding rhythm is probably due to its omnivorous habit. In ponds where any amount of organic debris, mud, etc. is available, the fish consumes a lot of these substances in addition to its other food. These substances contribute quite substantially to the total weight of food and thus make the rate of feeding steady throughout the year.

(*To be continued*)

A new species of *Angulitermes* from North India (Isoptera: Termitidae: Termitinae)

BY

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(*With three plates*)

Angulitermes akhorisainensis sp. nov.

Material

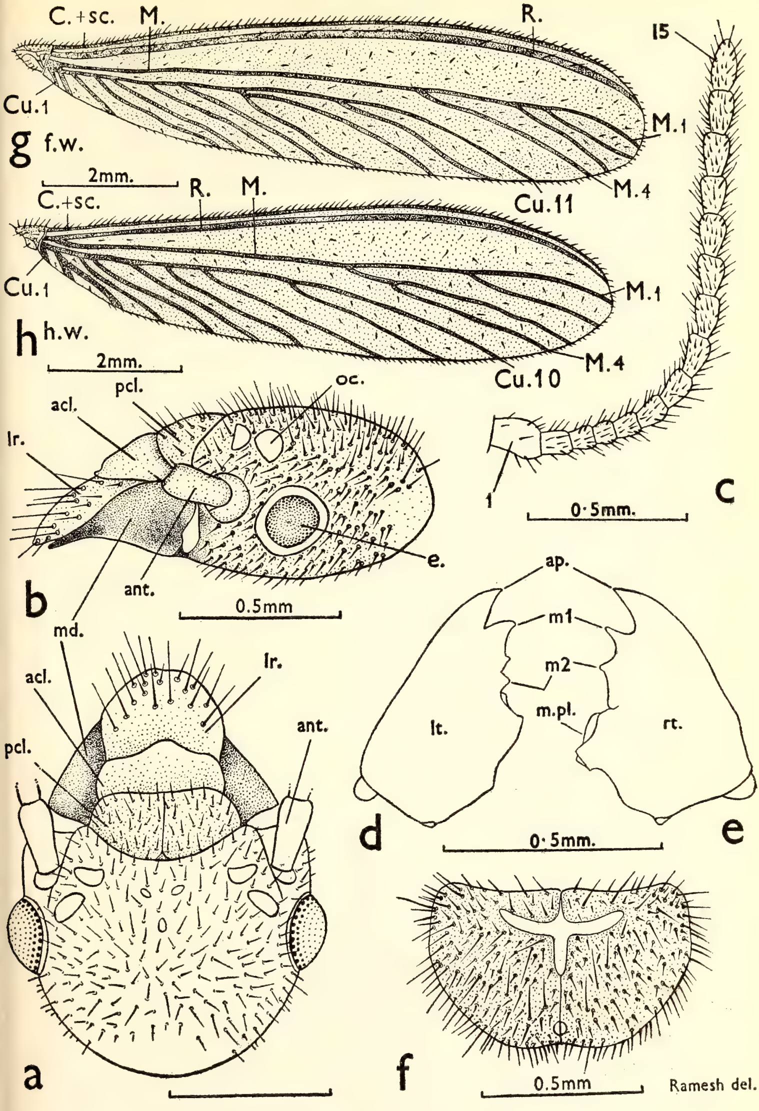
One spirit vial (No. 17) containing 16 imagines, 5 soldiers, and 4 workers collected from Akhorisain block (7000 feet above sea-level), Tehri Range, Tehri Garhwal Forest Division, U.P., by Avinash Chandra, on 5 June 1962 under stone.

Description

1. Imago (Plate I)

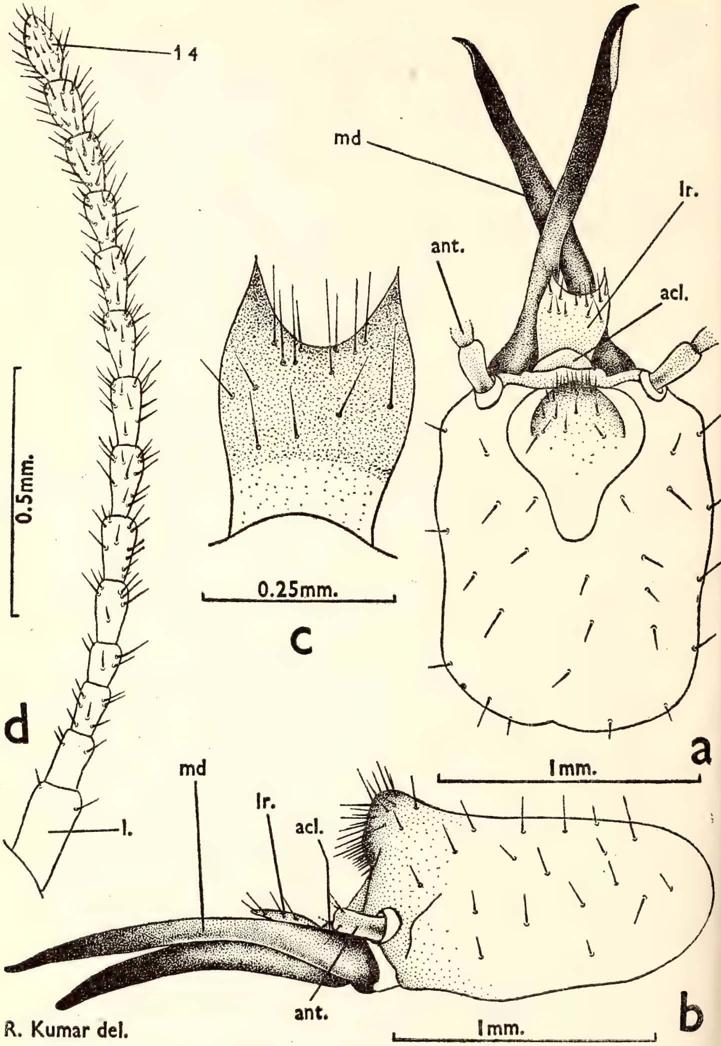
General. Head-capsule chocolate colour with greenish tinge; post-clypeus light castaneous brown; labrum pale brown; antennae infuscated, paler distally; pronotum slightly paler than head-capsule, with a pale yellow transverse mark a little below the anterior margin. Abdomen with tergal segments uniformly coloured, with light yellow intertergal portions; sterna light castaneous brown; legs tinged with yellow brown colour. Head and body densely pilose. Total body-length with wings *c.* 11.00-11.50 mm.; without wings *c.* 6.00-6.90 mm.

Head. Head-capsule sub-oval, wider than long (up to lateral base of mandibles); maximum length 0.75-0.85 mm.; maximum width 0.90-0.95 mm.; widest across the eyes; posterior margin round. *Epicranial-suture*: Absent. *Fontanelle*: Small, longitudinal, slit-like, situated at the base of apical third of head-capsule. *Antennae*: 15-segmented; 1st segment largest; 2nd cylindrical, longer than 3rd; 3rd longer than 4th; 5th onward progressively increasing in length, last cone-shaped. *Eyes*: Large, black, sub-circular; separated from the lower margin of head by half their short diameter (without ocular sclerites). *Ocelli*: Oval,



Angulitermes akhorisainensis sp. nov., caste : Imago

(*a*) head, dorsal view ; (*b*) head, side view ; (*c*) right antenna ; (*d*) left mandible ; (*e*) right mandible ; (*f*) pronotum, dorsal view ; (*g*) left forewing ; (*h*) left hindwing acl., anteclypeus ; ant., antenna ; ap., apical teeth ; C.+sc., fused costa and subcosta ; Cu.1-Cu.11., 1st to 11th cubital branches ; e., eye ; f.w. forewing ; h.w. hindwing ; lr., labrum ; lt., left ; m1.-m2., 1st and 2nd marginal teeth ; md., mandible ; M., median ; M.1-M.4., 1st-4th median branches ; m. pl., molar plate ; oc., ocellus ; pcl., postclypeus ; R., radius ; rt., right



Angulitermes akhorisainensis sp. nov., caste: Soldier

(*a*) head, dorsal view; (*b*) head, side view; (*c*) labrum; (*d*) right antenna
acl., anteclypeus; ant., antenna; lr., labrum; md., mandible

translucent, separated from the eyes by their short diameter. *Labrum*: Large, wider than long; widest near the middle; anterior margin narrowed and rounded; pilose. *Clypeus*: Postclypeus large, swollen, somewhat kidney-shaped, posterior margin convex, anterior margin concave; length about half its width; divided by a wide longitudinal median line; densely pilose. Anteclypeus trapezoid, prominent. *Mandibles*: Straw-coloured, with dark brown inner toothed margins. Left mandible with one apical, two marginals, and a blunt projection; apical large, finger-like, slightly incurved near the tip; 1st marginal large with posterior margin strongly sinuate, ending in a pseudo-tooth; 2nd marginal small. Right mandible with one apical, two marginals and a molar plate; apical tooth similar to that of left mandible; 1st and 2nd marginals sub-equal; molar plate prominent, upper margin concave.

Thorax. *Pronotum*: Flat, inner margin slightly elevated, concave, weakly notched medially; posterior margin distinctly emarginate; densely hairy. *Legs*: Long, slender and thickly pilose; tibial spurs 3 : 2 : 2; tarsi 4-segmented.

Wings. Dark grey; densely covered with fine granules; margins beset with numerous short hairs, surface with scattered short hairs. *Forewing*: Costa and subcosta fused, running parallel and close to prominent radius; median arising independently midway between the radius and cubitus outside the wing scale, bifurcating near the posterior third of wing, both inner and outer branches either simple or with 1-4 and 1-5 branches respectively; cubitus variable, with 7-11 branches. *Hindwing*: Costa, subcosta, and radius as in forewing; median arising from the radius well behind the wing scale, otherwise similar to that of forewing; cubitus also as in forewing. The wings of both sides of the same individual frequently differ.

Abdomen. Elongate, hairy; cerci short, 2-segmented and hairy.

2. SOLDIER (Plate II)

General. Head-capsule pale yellow to straw yellow; antennae and labrum slightly paler than head-capsule; mandibles dark reddish brown; body whitish yellow. Head sparsely, body moderately pilose. Approximate total body-length 4.10-4.60 mm.

Head. Head-capsule rectangular dorsally, longer than wide; widest near the anterior angles; sides sinuate; posterior margin broadly rounded. Frontal projection prominent, bluntly rounded, somewhat cone shape from above; in profile, dorsal surface somewhat sinuate, anterior border straight; densely pilose. *Fontanelle*: Lying below the frontal projection, prominent, and hairy. *Eyes* and *Ocelli*: Absent. *Antennae*: Arising from the dorsum of head-capsule; 14-segmented,

long and filiform ; pilose, pilosity increasing towards the distal segments; 1st largest ; 2nd and 3rd sub-equal ; 4th shortest ; 5th to 8th progressively increasing, 9th to 14th gradually decreasing in length. *Clypeus* :

TABLE I

BODY-MEASUREMENTS (IN MM.) OF *Angulitermes akhorisainensis* sp. nov., CASTE : IMAGO (six specimens measured)

Body-parts	Range	Mean
I. GENERAL		
1. Total body-length with wings ..	11.00-11.50	11.22
2. Total body-length without wings ..	6.00- 6.90	6.30
II. HEAD		
3. Length of head to lateral base of mandibles ..	0.70- 0.85	0.78
4. Maximum width of head with eyes ..	0.90- 0.95	0.92
5. Maximum height of head ..	0.45- 0.55	0.48
6. Length of labrum ..	0.25- 0.30	0.28
7. Width of labrum ..	0.35- 0.40	0.39
8. Long diameter of eye without sclerites ..	0.18- 0.20	0.19
9. Short diameter of eye without sclerites ..	0.15- 0.18	0.16
10. Length of ocellus ..	0.10- 0.12	0.10
11. Width of ocellus ..	0.08- 0.09	0.08
12. Eye-ocellus distance (without ocular sclerites) ..	0.08- 0.09	0.08
III. THORAX		
13. Length of pronotum ..	0.48- 0.55	0.51
14. Width of pronotum ..	0.75- 0.80	0.78

Postclypeus yellow, short and slightly swollen. Anteclypeus white, longer than postclypeus. *Labrum* : Subquadrate, sides converging posteriorly ; widest anteriorly ; anterior margin deeply concave with antero-lateral horns. *Mandibles* : Long, slender, of snapping type ; bow-shaped in side view, slightly longer than head-capsule, outer margin sinuate, conspicuously hooked apically. *Postmentum* : Club-shaped, pilose ; widest near the base of apical third ; sides parallel up to basal two-third, then converging anteriorly ; anterior margin truncate ; posterior margin subconcave.

Thorax. *Pronotum* : Strongly saddle-shaped ; anterior lobe considerably raised ; anterior margin weakly convex, posterior margin somewhat

TABLE II

BODY-MEASUREMENTS (IN MM.) OF *Angulitermes akhorisainensis* sp. nov., CASTE : SOLDIER (five specimens measured)

Body-parts	Range	Mean
I. GENERAL		
1. Total body-length ..	4.10-4.60	4.38
II. HEAD		
2. Head-length to base of mandibles ..	1.35-1.40	1.37
3. Head-length to tip of fontanelle ..	1.30-1.35	1.32
4. Maximum width of head ..	1.00-1.05	1.01
5. Maximum height of head (excluding postmentum but including frontal projection) ..	0.75-0.85	0.80
6. Head-index I (Width/length) ..	0.72-0.75	0.74
7. Head-index II (Height/width) ..	0.75-0.85	0.79
8. Head-index III (Height/length) ..	0.56-0.63	0.59
9. Fontanelle index (Head-length to fontanelle/ Head-length to base of mandibles) ..	0.94-0.96	0.95
10. Length of labrum (excluding lateral horns) ..	0.18-0.23	0.20
11. Maximum width of labrum ..	0.25-0.30	0.28
12. Length of mandibles		
(*a*) Right mandible ..	1.35-1.45	1.40
(*b*) Left mandible ..	1.35-1.45	1.40
13. Head-mandibular index (Left mandible length/Head-length to mandibular base) ..	1.00-1.04	1.02
14. Min. median length of postmentum ..	0.45-0.48	0.46
15. Maximum width of postmentum ..	0.28-0.33	0.30
16. Minimum width of postmentum ..	0.18-0.20	0.19
III. THORAX		
17. Length of pronotum ..	0.20-0.25	0.22
18. Maximum width of pronotum ..	0.45-0.55	0.50

straight; weakly notched medially both anteriorly and posteriorly; pilose. *Legs* : Relatively long, slender, and pilose ; tibial spurs 3 : 2 : 2 ; tarsi 4-segmented.

Abdomen. Short, hairy.

3. WORKER (Plate III)

General. Head-capsule pale yellow to straw yellow, with central whitish glandular portion; mandibles straw-coloured with dark brown toothed margin; postclypeus of same colour as head-capsule; labrum, antennae, and legs paler than head-capsule. Head moderately and body densely hairy. Approximate total body-length 4.00-4.50 mm.

Head. Head-capsule suboval, wider than long (up to lateral base of mandibles); posterior margin round. *Epicranial-suture, Eyes* and *Ocelli*: Absent. *Fontanelle*: Not visible. *Antennae*: 14-segmented; 1st largest; 2nd longer than 3rd; 3rd somewhat subequal to 4th; 5th onward progressively increasing in length; last cone-shaped. *Clypeus* and *Labrum*: As in imago. *Mandibles*: of *Angulitermes* type.

Thorax. *Pronotum*: Strongly saddle-shaped; anterior lobe considerably raised; anterior and posterior margins convex and without any emargination. *Legs*: Short (relatively to body) slender and pilose; tibial spurs 3 : 2 : 2; tarsi 4-segmented, hairy.

Abdomen. Oblong, transparent, hairy; cerci 2-segmented and hairy.

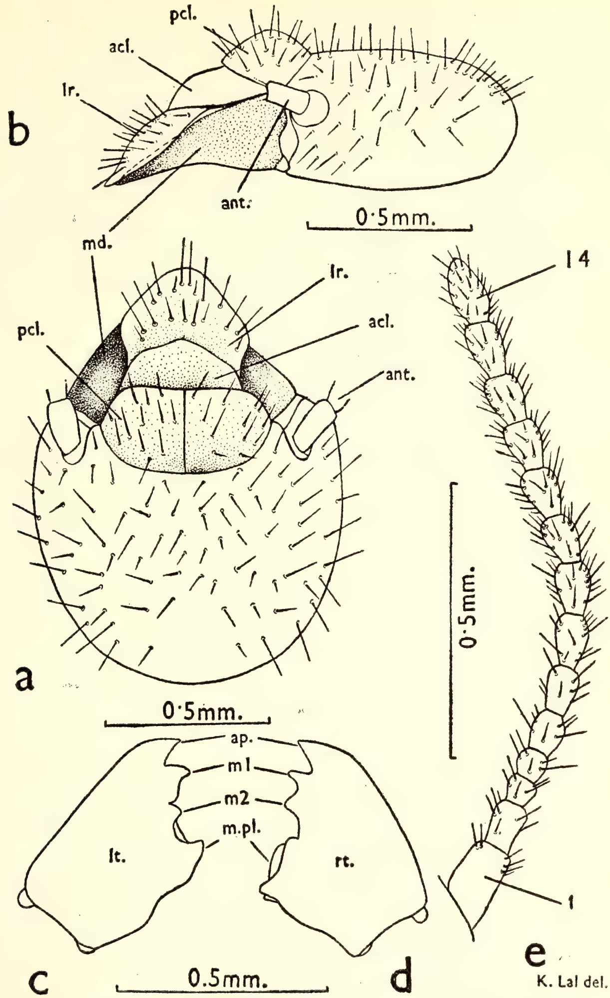
TABLE III
BODY-MEASUREMENTS (IN MM.) OF *Angulitermes akhorisainensis* sp. nov., CASTE: WORKER (four specimens measured)

Body-parts	Range	Mean
I. GENERAL		
1. Total body-length ..	4.00-4.50	4.30
II. HEAD		
2. Head-length to base of mandibles ..	0.70-0.80	0.74
3. Maximum width of head ..	0.80-0.90	0.86
4. Length of postclypeus ..	0.25-0.30	0.28
5. Maximum width of postclypeus ..	0.45-0.50	0.48
III. THORAX		
6. Length of pronotum ..	0.20-0.25	0.22
7. Width of pronotum ..	0.50-0.55	0.52

TYPE SPECIMENS

All the specimens from a single source as under heading 'Material' are deposited as follows:

(i) *Holotype* and *Morphotype*. One holotype soldier and a morphotype imago and worker $\left(\text{M. C. No.}\frac{20324}{1}\right)$ in a vial, from



Angulitermes akhorisainensis sp. nov., caste: Worker

(*a*) head, dorsal view; (*b*) head, side view; (*c*) left mandible; (*d*) right mandible; (*e*) right antenna

acl., anteclypeus; ant., antenna; ap., apical tooth; lr., labrum; lt., left; m1-m2., 1st and 2nd marginal teeth; m.pl., molar plate; p.cl., postclypeus; rt., right

Akhorisain block (7000 feet above sea-level), Tehri Range, Tehri Garhwal Forest Division, U.P., coll. Avinash Chandra, on 5 June 1962, deposited in Entomological Collection, Forest Research Institute, Dehra Dun (U.P., India).

(ii) *Paratypes* and *Paramorphotypes.* The paratype soldiers, paramorphotype imagos and workers from the holotype lot are deposited as follows: (1) One soldier, two imagines, and one worker, $\left(\text{M. C. No. } \frac{20324}{2}\right)$ in separate vials in (*a*) National Zoological Collection, Zoological Survey of India, Calcutta, (*b*) Prof. Emerson Collection, Chicago University, Chicago (U.S.A.). (2) Rest of the paratype soldiers, paramorphotype imagos and workers deposited in Entomological Collection, Forest Research Institute, Dehra Dun (U.P. India).

Type Locality

India : Uttar Pradesh : Akhorisain block (7000 feet above sea-level), Tehri Range, Tehri Garhwal Forest Division.

Geographical Distribution

Known only from the type locality.

Comparison

This new species is close to *Angulitermes dehraensis* (Gardner) and *A. acutus* Mathur & Sen-Sarma, but can be separated as follows:

From *A. dehraensis* (Cotype examined and compared) :

Imago: (i) Larger in size, (ii) Chocolate colour with greenish tinge (*v.* dark brown in *dehraensis*), (iii) Ocelli farther from eyes, eye-ocellus distance equal to its short diameter (*v.* less than its short diameter in *dehraensis*), (iv) Eyes separated from the lower margin of the head by half their short diameter (*v.* less than half diameter in *dehraensis*), (v) Median dividing line of postclypeus more prominent and wide (*v.* fine and less prominent in *dehraensis*), (vi) Median vein always bifurcated (*v.* not always bifurcated in *dehraensis*), (vii) Cubitus with lesser number of veins (7-11) *v.* 10-14 in *dehraensis.*

Soldier : (i) Frontal projection upright, somewhat conical from above, and with straight anterior border in side view (*v.* protruded forward and with a small notch in the lower half in *dehraensis*), (ii) Labrum with more convergent sides posteriorly (less convergent in *dehraensis*), (iii) Postmentum comparatively wider than in *dehraensis.*

From *A. acutus* (Paratype examined and compared) :

Soldiers : (i) Large species, (ii) Frontal projection less prominent and without any pointed tip (*v.* prominent and with a pointed tip in *acutus*), (iii) The front margin of labrum more deeply concave (*v.* broadly concave in *acutus*), (iv) Tibial spurs 3 : 2 : 2 (*v.* 2 : 2 : 2 in *acutus*).

A Contribution to our Knowledge of the Flora of the Mahendragiri Hills of Orissa

BY

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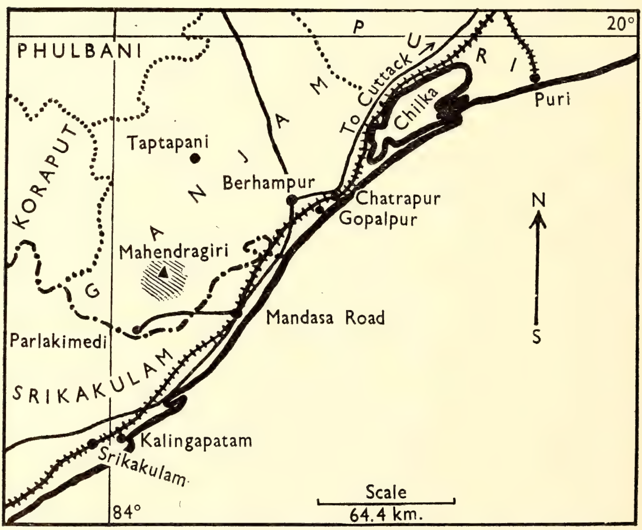
(*With a map*)

Introduction

The botanical study of the various hills of Bihar, Orissa, and Madhya Pradesh has been considered interesting from the point of



Map showing location of Mahendragiri Hills

view of floristics, plant-geography, as well as other information having bearing on geographical theories. Among others the Mahendragiri Hills,

falling in the past in Madras Presidency but now in Orissa, have attracted the attention of botanical workers from time to time though, unlike Parasnath and Pachmarhi, they have perhaps never been intensively explored. Gamble, as early as 1892, published a list of 34 species of ferns collected on the hills by Mrs. Sewell, the wife of the sub-collector posted in the region. He considered the botany of the hills 'extremely interesting, for on Mahendragiri seem to meet the North and the South, the Himalayas and the Nilgiris'.

The species of ferns reported by Gamble in his paper are: *Adiantum capillus-veneris* L., *A. caudatum* L., *A. lunulatum* Burm., *Alsophila glabra* (Bl.) Hook., *Angiopteris evecta* (Forst.) Hoffm., *Asplenium crinigerum* Bedd., *A. drepanophyllum* Baker [*Athyrium falcatum* Bedd.], *A. esculentum* Presl. [*Diplazium esculentum* (Retz.) Sw.], *A. laciniatum* Don, *A. oxyphyllum* Hook. [*Athyrium drepanopterum* (Ktze.) A. Br.], *Blechnum orientale* L., *Cheilanthes farinosa* (Forsk.) Kaulf., *C. tenuifolia* (Burm.) Sw., *Cyathea spinulosa* Wall., *Davallia pulchra* Don, *D. tenuifolia* Sw. var. *chinensis* [*Odontosoria chinensis* (L.) J. Sm.], *Gleichenia dichotoma* Willd. [*G. linearis* (Burm.) Cl.], *Hemionitis arifolia* (Burm.) Moore, *Lygodium pinnatifidum* Sw. [*L. flexuosum* (L.) Sw. et *L. polystachyum* Wall.], *Nephrodium cicutarium* Baker [*Aspidium cicutarium* (L.) Sw.], *N. cochleatum* Don [*Dryopteris cochleata* (Don) C. Chr.], *N. molle* Desv. [*D. parasitica* (L.) O. Ktze.], *N. sparsum* Don [*D. sparsa* (Ham.) O. Ktze.], *N. unitum* L. [*D. unita* (L.) O. Ktze.], *Nephrolepis cordifolia* (L.) Pr., *N. exaltata* (L.) Schott, *Pellaea concolor* Langsd. et Fisch. [*Dryopteris concolor* (Langsd. et Fisch.) Kuhn], *Polypodium fissum* Bl. [*Cyclophorus porosus* (Wall.) Pr.], *P. lineare* Thunb., *P. membranaceum* Don, *P. multilineatum* Wall. [*Dryopteris moulmeinensis* (Bedd.) C. Chr.], *Pteris aquilina* L. [*Pteridium aquilinum* (L.) Kuhn], *P. pellucida* Presl. and *P. quadriaurita* Retz. [*P. biaurita* L.]. The names in brackets are the valid synonyms according to Christensen (1960).

In that publication Gamble regretted that he did not keep any list of the plants in general during his first visit to the hills. Later on, as a result of exploration done by Beddome, Gage, Gamble & Fischer, etc., the Madras Presidency FLORA (1915-35) recorded as many as eighty-seven species of angiosperms occurring on the Mahendragiri Hills. Mukherjee (1935), while reporting on an excursion to the hills conducted by Prof. Parija during the Christmas holidays of 1934, gave a list of sixty species of angiosperms, of which forty-nine are new to the list of Madras Presidency FLORA. He also tried to indicate on the basis of Parija's collection only, the extent of sub-tropical

plants in the flora of a high hill lying within the Tropics. He did not take into account the species already reported from Mahendragiri in THE FLORA OF THE MADRAS PRESIDENCY, of which he cites Parts 1-8 as literature consulted. Mooney (1950) reported two more species which he came across while consulting the herbarium of the Ravenshaw College, Cuttack, with a view to bring out a supplement to Haines's THE BOTANY OF BIHAR AND ORISSA. Mooney himself did not explore the Mahendragiri Hills intensively, as the area lay outside the territorial scope of Haines's flora. However, he has called 21 species of Mukherjee's list interesting, and has specially included them in his supplement.

The author has had the privilege of botanizing at the Mahendragiri Hills and of examining the collections brought by the parties of the National Botanic Gardens, Lucknow, under the leadership of Sri G. S. Srivastava of this institution, in the years 1956 and 1959. Of the 366 species recorded in the list as many as 228 are new to the area.

The present paper gives a comprehensive list of all the species of angiosperms occurring on the Mahendragiri Hills, together with notes on location, approach, and geology, and a brief analysis of the flora. A detailed ecological account of the vegetation will be published elsewhere.

LOCATION AND GEOLOGY (based on IMPERIAL GAZETTEER, 1886)

The Mahendragiri Hills, are a part of the chain of the Eastern Ghats passing through the Ganjam District of Orissa. The Hills are situated at a distance of about 25-27 km. from the Bay of Bengal. The highest peak named as Bhim-raj Daur (18° 58′ N., 84° 26′ E.) rises to an elevation of 1500 m. (4923 feet).

Mahendragiri Hills are approachable via Mandasa Road, a railway station in Srikakulam District, Andhra. Mandasa town is 6.4 km. (4 miles) west of Mandasa Road, wherefrom a jeepable road goes near to the foot of the hills. The hills start after a walk of about 0.8 km. (half a mile).

The hilly plateau is formed of porphyritic gneiss embedding large crystals of felspar, but the higher peaks are of granitic gneiss in huge prismatic blocks.

CLIMATIC DATA

In the absence of any meteorological observatory on the Mahendragiri Hills, it is not possible to give complete climatic data for the

area. However, the area lies in the region which receives 100-150 cm. (40-60 inches) of annual rainfall.

STATISTICS

A survey of the flora of the Mahendragiri Hills reveals that the families represented by more than 10 species are in order of dominance as follows: Leguminosae, Compositae, Acanthaceae, Euphorbiaceae, Rubiaceae, and Cyperaceae. Labiatae and Gramineae, both of which are represented by equal number of species, follow soon after, and Urticaceae and Malvaceae, again with equal number of species, come last.

It is interesting to compare the dominant families of Mahendragiri flora with similar lists drawn up for Bihar and Orissa (Haines's BOTANY), Madras Presidency (Gamble's FLORA), and the whole of India (Hooker's FLORA) which are as follows:

	MAHENDRAGIRI HILLS	BIHAR AND ORISSA	MADRAS PRESIDENCY	BRITISH INDIA
1.	Leguminosae	Leguminosae	Leguminosae	Orchidaceae
2.	Compositae	Gramineae	Gramineae	Leguminosae
3.	Acanthaceae	Cyperaceae	Rubiaceae	Gramineae
4.	Euphorbiaceae	Compositae	Acanthaceae	Rubiaceae
5.	Rubiaceae	Euphorbiaceae	Euphorbiaceae and	Euphorbiaceae
6.	Cyperaceae	Acanthaceae	Orchidaceae	Acanthaceae
7.	Labiatae and	Rubiaceae and	Compositae	Compositae
8.	Gramineae	Orchidaceae	Cyperaceae	Cyperaceae
9.	Urticaceae and	Labiatae	Labiatae	Labiatae
10.	Malvaceae	Scrophulariaceae	Asclepiadaceae	Urticaceae

The comparison made above shows that the dominant families of the Mahendragiri flora are almost the same as those of British India of Hooker's FLORA. The order of dominance, however, differs and the family Orchidaceae does not find any place among the first ten. This may be due to the various factors not conducive here for the presence of orchids. The upper slopes of the hills are too exposed and orchids as a rule cannot endure the scorching effect of the full direct beams of a tropical sun. Further as the area receives only 100-150 cm. (40-60 inches) of rain annually it does not compensate the scorching effect of the sun. Mooney thought that the exposed nature of the upper slopes of the hills was responsible for the absence of *Pteridium aquilinum* (Linn.) Kuhn also from this area.[1]

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[1] However, *P. aquilinum* had been reported to occur on Mahendragiri by Gamble (1892).

The family Scrophulariaceae, with its seven species, occupies 11th position in the flora of Mahendragiri whereas it is 10th in the list for Bihar and Orissa, and this compares well. However, the family Asclepiadaceae, which is 10th in Madras Presidency flora, is represented on Mahendragiri Hills by only 4 species.

The ratio between the families of monocotyledons and dicotyledons is nearly 1:5.8; for the genera and the species the ratio comes to about 1:7.2 and 1:8.4 respectively. Further explorations, however, may yield more species of monocotyledons.

Influence of North and South Indian flora

Fischer has divided the Madras Presidency roughly into five main floristic regions. He has included the district of Ganjam along with the hill tracts of the surrounding area including Mahendragiri Hills in 'The Sal Region'. It is the flora of Mahendragiri and that of other high hills of the area having species of northern tracts and abundant presence of *Shorea robusta* throughout the sal region which separates it from the next, 'The Dekkan Region'. The latter region otherwise would be difficult to demarcate from the former.

The characteristic tropical as well as temperate species of the northern tracts found on the Mahendragiri Hills are *Clematis roylei, Capparis olacifolia, Viola patrinii, Homalium nepalense, Fagara budrunga, Natsiatum herpeticum, Rhamnus nepalensis, Crotalaria alata, Millettia auriculata, Bauhinia vahlii, Acacia catechu, Anotis calycina, Senecio nudicaulis, Lindenbergia gradiflora, Melasma arvense, Echinacanthus attenuatus, Callicarpa arborea, Ajuga macrosperma, Cinnamomum caudatum, Litsea laeta, L. monopetala, Balanophora polyandra, Bridelia pubescens, Euphorbia edgeworthii, Dendrobium bicameratum, Eria bambusifolia, Dioscorea glabra* and *Carex baccans*. The temperate species *Thalictrum foliolosum* has not been included in Madras Presidency flora but Haines in his BOTANY OF BIHAR AND ORISSA remarks: 'Specimens named *T. javanicum* in the *Cal. Herb.* collected by Gamble from Palamau and Mahendragiri (Ganjam) not in flower nor fruit appear to be *T. foliolosum*.' *Dicliptera bupleuroides* though found throughout India in the hills at 305-1830 m. (1000-6000 ft.) is more abundant in the north than in the south.

The important south Indian species represented in the Mahendragiri Hills flora are *Clematis wightiana* (?), *Pterospermum heyneanum, Cipadessa baccifera, Gymnosporia emarginata, Alysicarpus racemosus, Pseudarthria viscida, Sophora glauca, Tephrosia roxburghiana, Osbeckia*

hispidissima, Memecylon edule, Bupleurum mucronatum, Pimpinella heyneana, Viburnum acuminatum, Knoxia linearis, Pavetta breviflora, Wendlandia gamblei, Anaphalis lawii, Blumea jacquemontii, Gynura lycopersicifolia, Senecio candicans, S. corymbosus, Vernonia divergens, Xantolis tomentosa, Diospyros candolleana, Linociera ramiflora, Alstonia venenata, Gymnema sylvestre, Exacum perrottetii, Ehretia buxifolia, Ipomoea diversifolia, Andrographis ovata, Barleria gibsoni, Daedalacanthus montanus, Ecbolium viride, Rungia parviflora var. *monticola, Strobilanthes jeyporensis, Thunbergia fragrans* var. *hispida, T. fragrans* var. *vestita, Leucas montana, Santalum album, Euphorbia rothiana, Gelonium lanceolatum, Macaranga peltata, Pouzolzia benettiana* var. *gardneri, Molineria finlaysoniana, Eriocaulon conicum, Cyrtococcum trigonum* and *Dimeria avenacea. Rhinacanthus nasuta,* a species which is distributed in Ceylon, Java, and Madagascar, and also cultivated throughout India, has been reported to be 'perhaps wild in Deccan Peninsula'. Similarly *Gmelina asiatica,* which is largely cultivated in gardens, has been reported to be wild in scrub forests of the Deccan peninsula.

The species of the northern region and those of the southern region, when considered quantitatively, are represented in the Mahendragiri flora in the ratio of nearly 1 : 1.5. This preponderance of the south Indian flora is obviously due to the geographical position of the Eastern Ghats.

The presence of a large number of Himalayan species on the hills of Bihar and Orissa is interesting. They have been explained by Haines (1921-25) to be the relic of the time when the hills of Chota Nagpur and Orissa were much higher and served as stepping-stones for the migration of species from the high lands of the Deccan peninsula to the newer Himalayas and vice versa. Biswas & Sampatkumaran (1949) have explained that they are a relic from the time when there was land connection between the Deccan peninsula and the Indo-Malayan region. Srivastava (1955), while discussing the flora of Parasnath, has observed that they are not a relic but an exchange of floras is taking place by the agencies of winds, migratory birds, and human beings. Although the influence of these agencies, which definitely take an important part in modifying the composition of the vegetation of an area from time to time, cannot be underrated, the other factors also cannot be ignored. Rao & Narayanaswamy (1960) consider the Himalayan species occurring on the various hills of Orissa etc. including Mahendragiri, 'as instances of either discontinuous distribution, or remnants of vegetation of bygone days, got isolated on account of ancient geological disturbances'.

Systematic Enumeration of Plants

Ranunculaceae

Clematis gouriana Roxb.
C. roylei Rehder
Clematis wightiana Wall. ?
Thalictrum foliolosum DC.
Thalictrum javanicum Bl.

Annonaceae

Polyalthia suberosa Benth. & Hook. f.

Menispermaceae

Cissampelos pareira Linn.
Cocculus hirsutus (Linn.) Diels.

Papaveraceae

Argemone mexicana Linn.

Capparidaceae

Capparis grandis Linn.
C. olacifolia Hook. f. & Thoms.
Cleome monophylla Linn.
C. icosandra Linn.

Violaceae

Hybanthus enneaspermus (Linn.) Muell.
Viola patrinii DC.

Bixaceae

Bixa orellana Linn.
Cochlospermum religiosum (L.) Alston

Flacourtiaceae

Homalium nepalense Benth.

Pittosporaceae

Pittosporum floribundum W. & A.

Portulacaceae

Portulaca oleracea Linn.

Guttiferae

Garcinia tinctoria Dunn

Malvaceae

Abutilon indicum Sweet
A. polyandrum Schlecht.
Hibiscus lobatus (Murr.) O. Ktze.
Kydia calycina Roxb.
Pavonia zeylanica Cav.
Sida acuta Burm. f.
S. rhombifolia Linn.
S. veronicaefolia Lamk.
Urena lobata Linn.
U. sinuata Linn.

STERCULIACEAE

Helicteres isora Linn.
Melochia corchorifolia Linn.
Pterospermum acerifolium Willd.
P. heyneanum Wall.
Waltheria indica Linn.

TILIACEAE

Corchorus aestuans Linn. non Forsk.
Grewia aspera Roxb.
Grewia hirsuta Vahl.
Triumfetta bartramia Linn.
Triumfetta pilosa Roth

LINACEAE

Reinwardtia indica Dumort.

ZYGOPHYLLACEAE

Tribulus terrestris Linn.

GERANIACEAE

Oxalis corniculata Linn.

RUTACEAE

Fagara budrunga Roxb.
Glycosmis pentaphylla Corr.
Murraya koenigii Spreng.
Toddalia aculeata Pers.

MELIACEAE

Azadirachta indica Juss.
Cipadessa baccifera Miq.
Melia azedarach Linn.

OLACACEAE

Natsiatum herpeticum Buch.-Ham.

CELASTRACEAE

Gymnosporia emarginata Roth
Gymnosporia rufa Lawson

RHAMNACEAE

Rhamnus nepalensis Lawson
Sageretia parviflora G. Don
Ventilago calyculata Tul.
Zizyphus nummularia (Burm. f.) W. & A.
Z. rugosa Lam.
Z. xylopyrus Willd.

AMPELIDACEAE

Leea edgeworthii Santapau

SAPINDACEAE

Cardiospermum halicacabum Linn.
Dodonaea viscosa Linn

Anacardiaceae

Buchanania lanzan Spreng.

Semecarpus anacardium Linn. f.

Leguminosae (Papilionaceae)

Alysicarpus racemosus Benth.
A. vaginalis DC. var. **nummularifolius** Baker
Butea monosperma (Lamk.) Taub.
Cajanus cajan (L.) Millsp.
Cantharospermum scarabeoideum Benth.
Clitoria ternatea Linn.
Crotalaria alata Hamilt. ex Roxb.
C. albida Heyne
C. prostrata Roxb.
C. sericea Retz.
Derris scandens Benth.
Desmodium diffusum DC.
D. gangeticum DC.
D. latifolium DC.
D. pulchellum Benth.
D. triflorum DC.
Dolichos lablab Roxb.
Indigofera pulchella Roxb.
I. tinctoria Linn.
I. trita Linn. f.
Millettia auriculata Baker
M. ovalifolia Kurz
Moghania semialata Mukerjee
M. wightiana (Grah. ex Wall.) Mukerjee
Pongamia pinnata (Linn.) Pierre
Pseudarthria viscida W. & A.
Rhynchosia sericea Span.
Shuteria vestita W. & A.
Smithia conferta Sm.
Sophora glauca Lesch.
Tephrosia roxburghiana Drumm.
T. villosa Pers.
Teramnus labialis Spreng.

Caesalpiniaceae

Bauhinia racemosa Lamk.
B. purpurea Linn.
B. vahlii W. & A.
Caesalpinia digyna Roth
Cassia occidentalis Linn.
Tamarindus indicus Linn.

Mimosaceae

Acacia catechu Willd.
A. leucophloea Willd.
A. pennata Willd.
Albizia odoratissima Benth.
Dichrostachys cinerea W. & A.
Leucaena glauca Benth.
Mimosa pudica Linn.
M. rubicaulis Lamk.

Rosaceae

Pygeum andersonii Hook. f.

Considered endemic to a fairly limited tract. It has been reported from Mahendragiri both in Gamble's FLORA as well as in that of Haines. Mukherjee, however, missed to include it in his list.

Combretaceae

Terminalia catappa Linn.

Terminalia chebula Retz.

Myrtaceae

Psidium guajava Linn.
Psidium pumilum Vahl
Syzygium cumini (L.) Skeels

MELASTOMACEAE

Memecylon edule Roxb.
Osbeckia hispidissima Wt.

LYTHRACEAE

Ammannia baccifera Linn.
Lawsonia inermis Linn.
Woodfordia fruticosa (L.) Kurz

ONAGRACEAE

Ludwigia parviflora Roxb.

SAMYDACEAE

Casearia tomentosa Roxb.

CUCURBITACEAE

Bryonopsis laciniosa (L.) Naud.
B. scabrella Linn.
Cucumis sativus Linn.
Momordica charantia Linn.
Trichosanthes bracteata (Lamk.) Voigt.

FICOIDAE

Mollugo nudicaulis Lamk.
Trianthema portulacastrum Linn.

UMBELLIFERAE

Bupleurum mucronatum W. & A.
Centella asiatica (L.) Urban
Pimpinella bracteata Haines
P. heyneana Wall.

ARALIACEAE

Schefflera venulosa (W. & A.) Harms.

ALANGIACEAE

Alangium salvifolium (L. f.) Wang.

CAPRIFOLIACEAE

Viburnum acuminatum Wall.

RUBIACEAE

Adina cordifolia Hook. f.
Anotis calycina Wall.
Borreria hispida (L.) Schum.
Canthium dicoccum (Gaertn.) Merr.
Dentella repens Forst.
Galium asperifolium Wall.
Gardenia latifolia Ait.
Hamiltonia suaveolens Roxb.
Knoxia corymbosa Willd.
K. linearis Gamble
Lasianthus truncatus Bedd.
Oldenlandia corymbosa Linn.
O. nudicaulis Roth
Pavetta breviflora DC.
Rubia cordifolia Linn.
Wendlandia gamblei Cowan
Wendlandia tinctoria DC.

COMPOSITAE

Ageratum conyzoides Linn.
Anaphalis lawii Gamble
Blumea jacquemontii Hook. f.
Blumea [sp.? **mollis** (D. Don) Merr.]
Centratherum anthelminticum (Willd.) Ktze.
Conyza aegyptiaca Ait.
C. japonica Less.
Crepis acaulis Hook. f.
Eclipta prostrata (Linn.) Linn.
Elephantopus scaber Linn.
Eupatorium odoratum Linn.
Gnaphalium luteoalbum Linn. var. **multiceps** Hook. f.
Gnaphalium luteoalbum Linn. var. **pallidum** Hook. f.
Guizottia abyssinica Cass.
Gynura lycopersicifolia DC.
Laggera alata Sch.-Bip.
L. pterodonta Benth.
Senecio candicans DC.
S. corymbosus Wall.
S. nudicaulis Ham.
Siegesbeckia orientalis Linn.
Tagetes erecta Linn.
Tridax procumbens Linn.
Vernonia cinerea Less.
V. divergens Edgew.
Vicoa indica Linn.
Xanthium strumarium Linn.

CAMPANULACEAE

Campanula canescens Wall.

MYRSINACEAE

Ardisia solanacea (Poir.) Roxb.

SAPOTACEAE

Xantolis tomentosa (Roxb.) Rafin.

EBENACEAE

Diospyros candolleana Wt.
Diospyros peregrina (Gaertn.) Gurke

OLEACEAE

Jasminum arborescens Roxb.
J. grandiflorum Linn.
Linociera ramiflora (Roxb.) Wall. ex G.Don
Olea glandulifera Wall.

APOCYNACEAE

Alstonia venenata R. Br.
Carissa gangetica Stapf
C. spinarum A. DC.
Holarrhena antidysenterica Br.
Ichnocarpus frutescens Br.
Nerium indicum Mill.
Tabernaemontana divaricata Br.
Vallaris solanacea (Roth) O. Ktze.
Wrightia tinctoria Br.

ASCLEPIADACEAE

Calotropis gigantea Br.
Cryptolepis buchanani R. & S.
Gymnema sylvestre Br.
Hemidesmus indicus Br.

Loganiaceae

Strychnos nux-vomica Linn.

Gentianaceae

Canscora decussata R. & S.
C. diffusa Br.
Exacum perrottetii Griseb.
Swertia angustifolia Buch.-Ham. var. **pulchella** Burkill

Boraginaceae

Coldenia procumbens Linn.
Cynoglossum sp.
Ehretia buxifolia Roxb.
E. laevis Roxb.
Heliotropium indicum Linn.

Convolvulaceae

Argyreia nervosa (Burm. f.) Boj.
Evolvulus alsinoides Linn.
Ipomoea angulata Lamk.
Ipomoea barlerioides Benth. & Hook. f.
I. diversifolia R. Br.
I. nil (L.) Roth

Solanaceae

Cestrum diurnum Linn.
Solanum indicum Linn.

Scrophulariaceae

Limnophila indica (L.) Druce
Lindenbergia grandiflora Benth.
L. indica (L.) O. Ktze.
Melasma arvense (Benth.) Pennell
Scoparia dulcis Linn.
Sopubia trifida Buch.-Ham.
Torenia cordifolia Roxb.

Lentibulariaceae

Utricularia striatula Sm.

Gesneraceae

Rhyncoglossum obliquum Bl.

Acanthaceae

Adhatoda vasica Nees
Andrographis ovata Benth.
A. paniculata Nees
Barleria gibsoni Dalz.[1]
B. prionitis Linn.
B. strigosa Willd.
Daedalacanthus montanus T. Anders.
Dicliptera bupleuroides Nees
Ecbolium viride (Forsk.) Alston
Echinacanthus attenuatus Nees
Hemigraphis latebrosa Nees
Justicia betonica Linn.
Justicia betonica L. var. **villosa** Cl.
J. diffusa Willd.
J. gendarussa Linn. f.
J. simplex D. Don
Rhinacanthus nasuta (L.) Kurz
Rungia parviflora Nees var. **monticola** Gamble
R. parviflora Nees var. **pectinata** Cl.
Strobilanthes jeyporensis Bedd.
Thunbergia fragrans Roxb. var. **hispida** Gamble
T. fragrans Roxb. var. **vestita** Nees

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[1] May this be *Barleria prattensis* Sant.?—Eds.

Verbenaceae

Callicarpa arborea Roxb.
Clerodendrum fragrans Willd.
Clerodendrum viscosum Vent.
Gmelina arborea Roxb.
Gmelina asiatica Linn.

Labiatae

Ajuga macrosperma Wall.
Anisomeles indica (L.) O. Ktze.
Colebrookea oppositifolia Sm.
Hyptis suaveolens Poit.
Leonotis nepetaefolia Br.
Leucas montana Spreng.
Nepeta hindostana (Roth) Haines
Ocimum sanctum Linn.
Plectranthus coetsa Buch.-Ham. ex Don
Pogostemon plectranthoides Desf.
Scutellaria discolor Colebr.

Nyctaginaceae

Boerhavia diffusa Linn.
Boerhavia repanda Willd.

Amaranthaceae

Achyranthes aspera Linn.
Alternanthera sessilis R. Br.
Amaranthus spinosus Linn.
Digera muricata (L.) Mart.

Polygonaceae

Polygonum barbatum Linn.
P. chinense Linn. var. **corymbosum** Meissn.
Polygonum chinense Linn. var. **ovalifolium** Meissn.
Polygonum punctatum Buch.-Ham.

Piperaceae

Peperomia reflexa A. Dietr.

Lauraceae

Beilschmiedia roxburghiana Nees
Cassytha filiformis Linn.
Cinnamomum caudatum Nees
Litsea laeta Wall.
L. monopetala (Roxb.) Pers.
Neolitsea zeylanica Merr.

Proteaceae

Grevillea robusta A. Cunn.

Loranthaceae

Scurrula cordifolia (Wall.) G. Don
Scurrula parasitica Linn.
Viscum nepalense Spreng.

Santalaceae

Osyris wightiana Wall. ex Wight
Santalum album Linn.

Balanophoraceae

Balanophora polyandra Griff.

Buxaceae

Sarcococca trinervia Wt.

Euphorbiaceae

Acalypha indica Linn.
Baliospermum montanum (Willd.) Muell.-Arg.
Bridelia montana Hook.
B. pubescens Kurz
Cleistanthus collinus Benth.
Croton bonplandianum Baill.
Drypetes assamica (Hk. f.) Pax & Hoffm.
Emblica officinalis Gaertn.
Euphorbia edgeworthii Boiss.
E. hirta Linn.
Euphorbia perbracteata Gage
E. rothiana Spr.
E. thymifolia Burm.
Gelonium lanceolatum Willd.
Glochidion velutinum Wt.
Jatropha curcas Linn.
Macaranga peltata (Roxb.) Muell.-Arg
Mallotus philippinensis Muell.
Phyllanthus debilis Ham.
P. niruri Linn.
Ricinus communis Linn.

Urticaceae

Boehmeria platyphylla Don
Ficus hispida Linn. f.
F. religiosa Linn.
F. tomentosa Roxb.
Holoptelea integrifolia Planch.
Lecanthus wightii Wall.
Morus indica Linn.
Pouzolzia bennettiana Wt. var. **gardneri** Hook. f.
Streblus asper Lour.
Trema orientalis Blume

Burmanniaceae

Burmannia coelestis Don

Orchidaceae

Dendrobium bicameratum Lindl.
Eria bambusifolia Lindl.

Scitaminaceae

Costus speciosus Sm.

Haemodoraceae

Ophiopogon intermedius Don

Amaryllidaceae

Curculigo orchioides Gaertn.
Molineria finlaysoniana Baker

Dioscoreaceae

Dioscorea glabra Roxb.

Liliaceae

Asparagus racemosus Willd.
Gloriosa superba Linn.

Commelinaceae

Commelina obliqua Ham.
Murdannia nudiflorum (L.) Brenan
Cyanotis axillaris R. & S.

Araceae

Alocasia sp. (? **decipiens** Schott)
Pistia stratiotes Linn.

Eriocaulaceae

Eriocaulon conicum Fischer

Cyperaceae

Carex baccans Nees
C. speciosa Kunth
Cyperus distans Linn. f.
C. iria Linn.
C. tenuispica Steud.
Fimbristylis bisumbellata Bub.
Kyllinga brevifolia Rottb.
Mariscus sp.
Pycreus pumilus Nees
P. sanguinolentus Nees
Scirpus squarrosus Linn.
Scleria cochinchinensis Druce

Gramineae

Arundinella pumila (Hochst.) Steud.
Capillipedium assimile (Hook. f.) Stapf
Chloris dolichostachya Lag.
Cynodon dactylon Pers.
Cyrtococcum oxyphyllum (Hochst. ex Steud.) Stapf
Cyrtococcum trigonum (Retz.) A. Camus
Digitaria setigera Roth apud R. & S.
Dimeria avenacea (Retz.) C. E. C. Fischer
Echinochloa colonum (L.) Link
Oplismenus compositus Beauv.
Thysanolaena maxima (Roxb.) O. Ktze.

Summary

The present paper gives a comprehensive list of the plants of the Mahendragiri Hills. As many as 228 species have been reported as new to the locality. In addition, short notes on location, geology, and climatic data have been inserted.

The families represented by more than 10 species, in order of dominance, are: Leguminosae, Compositae, Acanthaceae, Euphorbiaceae, Rubiaceae, Cyperaceae, Labiatae and Gramineae (having equal number of species), Urticaceae and Malvaceae (having equal number of species).

It has been observed that the flora has a larger number of south Indian representatives due to the geographical position of the Eastern Ghats.

The occurrence of Himalayan species on the hills of Orissa has been briefly discussed.

ACKNOWLEDGEMENTS

Thanks are due to Prof. K. N. Kaul, Director, National Botanic Gardens, Lucknow, for facilities for work and to my colleague Sri Hira Lal Yadav for help during identification of specimens.

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Notes on Migrant Birds of North Bihar

BY

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(*With two text-figures*)

In January 1964 I was deputed to north Bihar to study the local conditions and to assess the possibilities of ringing migratory birds particularly waders (Charadriiformes) and duck. The area surveyed extends from the north bank of the Ganges to the India-Nepal border in the central portion of north Bihar.

North Bihar is an absolutely flat alluvial plain, through which the many rivers that debouch from the Himalayas follow their rather slow and winding courses to the south. They have in general comparatively narrow channels which they frequently overflow, inundating considerable areas. Among these Kosi River requires particular attention, as it is responsible for the creation of favourable ecological conditions in central Bihar for the migrant species entering India from the north. The Kosi, Bihar's river of sorrow, is notorious for the desolation caused by its floods. The channels are constantly changing as old ones are choked by sandbanks (within the last seventy years the river has changed its course westwards for more than fifty miles) resulting in the production of innumerable *chaurs*[1] and *jheels*[2] which provide good feeding ground for waterfowl and wader migrants. To tame the Kosi and direct its course through a specified area embankments are being built on either bank at various places. The distance between the embankments varies from 4 to 10 miles or more and when the flood starts (from July onwards) the intervening area provides an excellent resort for the migrants. Deep water paddy (coarse paddy grown in low-lying inundated areas) is an added attraction to the migrants.

Vegetation

Trees occur around villages which are separated by extensive fields. Mango, pipal, and banyan are common, also neem and

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[1] *chaur*=low, water-logged meadow
[2] *jheel* =a marsh

tamarind. Palms, both palmyra and date, are found near fields. Bamboo brakes and silk cotton trees are infrequently met with.

Crops

Rice, wheat, and maize are the principal crops. Several varieties of gram, chilli, groundnut, tobacco, and sugarcane are also grown. Enlargement of cultivated areas is going to be one of the principal causes affecting the population of migrant birds in future.

In the intricate network of channels that traverse the plains grow *Vallisneria* sp.; *Pistia* sp., *Eichhornia* sp., and *Nymphaea* sp. were mainly seen in *chaurs*, *jheels*, and water-logged areas.

Climate

During the hot weather, from March to the middle of June, westerly winds blow over the arid sun-baked plains causing high temperatures and low humidity. The monsoon usually breaks in the third week of June and continues till September or early October. The cold season begins in November and nights are very cold in December and January. There are occasional showers during this period. The spring season is very brief, beginning in February and lasting till March. The average rainfall is *c.* 100 cm.

Itinerary

Monghyr District :

Manjhaul and Kabar Tal[1] (*c.* 10 and 14 miles respectively north of Begusarai railway station)	31 Jan. to 24 Feb. and 15 to 23 Mar. 1964

Darbhanga District :

Laheriaserai (3 miles south of Darbhanga)	24 to 26 Feb. 1964
Jamalpur village (*c.* 25 miles south of Ghogardiha railway station)	27-28 Feb., and 2 Mar. 1964
Supaul *jheel* (near Supaul village and 4 miles west of Jamalpur village)	3 Mar. 1964

Saharsa District :

Koniya *jheel* (*c.* 4 miles east of Kusheshwara-Astan)	29 Feb. and 1 Mar. 1964
Nirmali railway station	4 to 7 Mar. 1964
Birpur (Headquarters of Kosi River Project)	8, 11, 12, and 13 Mar. 1964

[1] *tal*=a shallow lake

Bhimnagar (4 miles west of Birpur)	9 Mar. 1964
Pratapganj (*c.* 18 miles south of Birpur)	10 Mar. 1964

Among the places visited none equalled Kabar Tal for the number and variety of waterfowl. Situated in the Begusarai subdivision of Monghyr District, Kabar Tal is accessible by road via Manjhaul. The lake is shallow for the most part and has an area of about eight square miles. During the rains the surrounding low-lying areas are inundated increasing the size of the lake. To the east of the lake are large areas studded with marshy hollows.

The lake is eutrophic sustaining a rich plant and animal life. The water is crystal clear and the soil, locally known as *kachhua keual,* is dark in colour. Emergent vegetation is rather patchy and sparsely distributed, except in the deeper areas of about 3 to 4 square miles where subaquatic vegetation is prolific. Water Hyacinth (*Eichhornia* sp.) near the water's edge was drying up at the time of my visit. There are no trees in the lake area.

Cormorants and darters were absent at the time of my visit (31 January to 24 February and 15 to 19 March), perhaps their absence is related to that of trees.

The lake was teeming with waterfowl of every description from 31 January to 22 February but when I visited the area on 19 March it was completely deserted except for 50 or 60 *Anas querquedula.* The lake is well stocked with fishes, which are replenished yearly by river floods; the principal species are members of the carp family. A good number of fishes is caught for sale. The water from the lake is drained through the Chandan, a tributary of the River Balan.

The Kabar Tal is very famous for duck shoots and it is puzzling why there is no mention of it in ornithological literature. With little effort the lake can be converted into one of the best waterfowl sanctuaries in India. At present, I understand, plans are afoot to drain off the water completely. If this scheme materializes the lake area will be turned into an expanse of dry fields by the end of November, an irrevocable loss of one of the most delightful natural lakes of India.

Next to Kabar the Koniya *jheel* has the largest number of waterfowl. This is also an extensive perennial lake of eutrophic nature. Between eight and ten thousand ducks of various kinds were seen on 1 March. I was informed that the number of waterfowl coming to the *jheel* has decreased considerably in recent years owing to the unrestricted growth of jungle (emergent vegetation) which the birds

find unsuitable. Waterfowl in thickly packed flocks were seen on the open water with luxuriant growth of subaquatic plants.

The following birds were recorded:

ANATIDAE

Tadorna ferruginea (Pallas): Brahminy Duck. Very common till March 10 on Kosi River. Seen invariably in pairs on the Ganges and on the Kosi. They preferred clear stretches of sandbank. Groups of 20 to 30 birds were common. The largest flock, seen near Dhalva on the Kosi, contained five to six hundred birds. Not seen on lakes or other standing water.

Anas acuta Linnaeus: Pintail. Common. Not in any numbers. Generally distributed in suitable places in the company of other ducks.

Anas crecca Linnaeus: Common Teal, and **Anas querquedula** Linnaeus: Garganey. Plentiful. The commonest ducks. From January 31 to the end of February *A. crecca* was seen in large numbers while *A. querquedula* was rather uncommon. By the end of February when the days become hotter most of the *A. crecca* left the area and its place was taken over by *A. querquedula*. On 19 March Kabar Tal was found completely deserted by waterfowl except for 50 or 60 *A. querquedula*.

During the heat of the day both species were observed resting in compact flocks in shallow waters of the low-lying reedy areas as well as on the sandy islands of the Kosi. Such flocks contained 500 to 1500 birds.

A couple of hundred *A. crecca* handled between 2 February and 18 March showed no signs of moulting of the primaries and secondaries or of the tail-feathers. Invariably all ♂♂ were in their brilliant breeding plumage. On the contrary *A. querquedula* ♂♂ without exception were in eclipse plumage in February and started getting the breeding attire by March.

The recovery from Kashmir (15-3-1964) of one of the *A. crecca* ringed at Manjhaul (Monghyr District, 6-2-1964) suggests that this species may not go directly across the Himalayas on its way back to its breeding ground.

Anas strepera Linnaeus: Gadwall. Seen in small numbers all over.

?Anas penelope Linnaeus: Wigeon. Scarce, seen only at Kabar.

Anas clypeata Linnaeus: Shoveller. Common, in moderate numbers. Noted in every suitable locality, and all in breeding plumage. No moulting of the primaries and secondaries or of tail-feathers in individuals examined between 18 February and 16 March.

Netta rufina (Pallas): Redcrested Pochard. This beautiful duck was seen in thousands at Kabar, in good numbers at Koniya *jheel*, and a few were present in most of the low-lying water-logged areas visited. All were in breeding plumage. At Kabar and Koniya *jheel* they were noted frequenting open stretches of water with plenty of submerged aquatic weeds. Next to coots this was the predominant species at Kabar between 19 and 21 February and kept to the company of its own species.

Aythya ferina (Linnaeus): Common Pochard. Common. Seen in good numbers in company with other pochards. Showed a liking for open waters.

Aythya nyroca (Güldenstädt): White-eyed Pochard. Very common. Seen in good numbers all over. In the swamps and marshy pockets east of Kabar, this species outnumbered other waterfowl. Here the majority rested during the hotter part of the day but a few fed singly or in pairs near the water's edge.

?Aythya baeri (Radde): Baer's Pochard. A pochard with greenish black neck and head seen at the Manjhaul bird market was probably of this species.

Aythya fuligula (Linnaeus); Tufted Duck. Common but not in any numbers.

Non-migrant species of ducks

Dendrocygna javanica (Horsfield): Lesser Whistling Teal. A flock of about 100 whistling teal in the company of cotton teal and coots was seen feeding in open water at Koniya *jheel*. Fairly tame and allowed a close approach to about 70 ft., when they arose with shrill notes and continued calling till they settled at a distance after making one or two rounds at a height of about 60 ft. Not seen elsewhere.

Nettapus coromandelianus (Gmelin): Cotton Teal. I saw this bird (12-15) only at Koniya *jheel*, in company with whistling teal.

Rhodonessa caryophyllacea (Latham): Pinkheaded Duck. Every effort was made to obtain information on this duck. A careful search of all suitable localities produced no results. Old shikaris and professional bird-catchers to whom a colour illustration of the bird was shown said that they had neither shot nor seen one.

In Kabar Tal and Koniya *jheel* during the day ducks were seen in thickly packed flocks floating on clear open stretches of water with plenty of submerged aquatic weeds. When a mixed party of ducks, teals, coots, and little grebes was approached in a countrycraft, the first to take notice and leave the spot were the teals. The ducks slowly swam away and the last to leave were the grebes and coots. Even

though ducks were frequently disturbed at Kabar by the shikaris and the moving countrycrafts, only on rare occasions did I see them leave the lake. Usually they flew to another portion of the lake.

During the heat of the day thousands of ducks, mainly *Anas querquedula, A. crecca, Aythya fuligula,* and *A. nyroca,* and perhaps other species also, were seen (on 28 February and 2 March) resting in thickly packed flocks on the sandy islands in the Kosi which were quite far away from the banks.

RALLIDAE

Fulica atra Linnaeus: Coot. Very common in suitable localities. This was the predominant species at Kabar Tal where I saw them in thousands, from 31 January to 23 February. When the area was revisited on 19 March none was observed.

CHARADRIIDAE

Vanellus leucurus (Lichtenstein): Whitetailed Lapwing. Seen singly at Nirmali on 5 March in a reedy low-lying area busily engaged in feeding near the water's edge.

Vanellus cinereus (Blyth): Greyheaded Lapwing. One seen in Manjhaul bird market.

Pluvialis dominica (P.L.S.Müller): Eastern Golden Plover. Common. Seen in good numbers, five to six hundred, flying towards Kosi River near Jamalpur on 28 February at 9 a.m. Also observed resting in thickly packed flocks on the exposed sandy portions of the Kosi and in moist grassy edges of water-logged low-lying areas near Jamalpur. Before settling down the flocks were noted making much aerial evolution in perfect unison around the place. All the birds handled and observed till 2 March were in winter plumage; none of them showed any trace of nuptial plumage.

Charadrius dubius Scopoli: Little Ringed Plover. Common, seen near water's edge.

Charadrius alexandrinus Linnaeus: Kentish Plover. As above.

Charadrius mongolus Pallas: Lesser Sand Plover. Two were brought to me on 16 March and one the next day. They were in non-breeding plumage and did not show signs of moulting.

Numenius arquata (Linnaeus): Curlew. Frequently heard at night. Seen near the Kosi, Kabar, and Jamalpur in moderate numbers. I

did not see them resting during the hotter part of the day even though they were seen with other waders which were inactive.

?Numenius tenuirostris Vieillot: Slenderbilled Curlew. Near Jamalpur I saw a party of seven curlews standing close together. Three or four were noticeably smaller, half *N. arquata*. At about 70 ft. distance I scrutinised them very carefully through the binoculars but failed to see the stripes on the crown characteristic of *N. phaeopus*. Hence I suspect them to be *N. tenuirostris*.

Limosa limosa (Linnaeus): Blacktailed Godwit. Common near Jamalpur frequenting swamps. On 28 February in water-logged area with thinly distributed emergent vegetation a tightly packed group of 60 to 80 birds was seen between 10 a.m. and 3.30 p.m. The flock strength was reduced to half when I visited the place after two days. I believe that a few among them were Bartailed Godwit *Limosa lapponica* (Linnaeus).

Tringa totanus (Linnaeus): Common Redshank. One was brought to me on 16 March at Manjhaul by *Mirshikars*. They informed me that this bird is common during the monsoon.

Tringa ochropus Linnaeus: Green Sandpiper, and **Tringa glareola** Linnaeus: Spotted Sandpiper. *T. ochropus* was very common and outnumbered *T. glareola* at Birpur and Bhimnagar; vice versa at Manjhaul, Nirmali, and Koniya *jheel*. February (2 to 19) individuals of *T. glareola* were moulting the outer 5th, 4th, or 3rd primaries. Most of the March (16 and 17) individuals had moulted the primary feathers and a few were moulting the two outermost feathers. In both February and March individuals body feathers were in moult.

Tringa hypoleucos Linnaeus: Common Sandpiper. Met with at all places, but was not common as one would expect it to be.

Capella stenura (Bonaparte): Pintail Snipe. Individuals examined (8 February to 16 March) showed no moulting of the primaries. Body feathers were in moult. My note on an individual collected on 16 March reads: 'outermost broad tail-feathers on either side moulting'.

Capella gallinago (Linnaeus): Common Snipe. Body feathers were moulting but no moult of primaries observed in the individuals checked (4 February to 16 March).

A small flock of *Capella* sp. (15 to 20) was seen near Jamalpur in the shallow regions of a water-logged area. The majority were inactive (11 a.m.) and a few were feeding. In the act of collecting food materials from water the whole head up to the neck is dipped into the water.

Capella minima (Brünnich): Jack Snipe. Three birds were brought to me by *Mirshikars* on 17 February at Manjhaul. I failed to see this bird in the field.

Calidris minutus (Leisler): Little Stint. Common. Number increased considerably by March. Out of the nineteen individuals examined (15 to 17 March) 13 were moulting the outer primaries, the rest had completed moult. Body feathers of all the individuals were in moult. Moulting of primaries is of the *descending* type, i.e. from inner towards outer. Only those birds which had completed the primary moult showed any breeding plumage.

Calidris temminckii (Leisler): Temminck's Stint. Common in February and became very common during March. 15 were moulting outer primaries, with 3 completed in 18 individuals examined on 16 and 17 March. All showed moulting of body feathers. The primary moulting is of the *descending* type. Only those birds which had completed primary moult showed any signs of breeding plumage. I was told by *Mirshikars* that *C. minutus* and *C. temminckii* change their plumage colour (? attain breeding plumage) before they leave the area.

Philomachus pugnax (Linnaeus): Ruff and Reeve. Very common in all places visited. All were in non-breeding plumage (7 March). Enormous numbers were seen resting on the sandy islands in the Kosi (4 to 6 thousand) and in water-logged areas (2 to 3 thousand) near Jamalpur, between 10 a.m. and 4 p.m.

Rostratulidae

Rostratula benghalensis (Linnaeus): Painted Snipe. I did not see any in the field. *Mirshikars* supplied me with two males.

Recurvirostridae

Himantopus himantopus (Linnaeus): Blackwinged Stilt. Common on mud-flats, shallow regions of *jheels* and *chaurs*. Three individuals handled on 17 March showed no signs of moulting. The wing length and weight of the birds are: ♂ wing 248 mm., wt. 192 gm.; ♀ wing 228 mm., wt. 158 gm.; ♀ wing 218 mm., wt. 160 gm.

Recurvirostra avosetta Linnaeus: Avocet. Two small flocks consisting of 32 and 38 individuals were seen resting on a sandy island

in the Kosi and in a low-lying water-logged area near Jamalpur on 29 February and 2 March respectively. Their species segregation in flight, alighting, and settling was striking.

Non-migrant members of the Charadriiformes noted were: *Hydrophasianus chirurgus* (Scopoli) (in twos and threes), *Metopidius indicus* (Latham) (flocks consisting of 20 to 30 birds; none of them had the long sickle-shaped tail-feathers), and *Vanellus indicus* (Boddaert) (in twos and threes) were common all over.

During the heat of the day waders were noted taking refuge on the sandy islands in the Kosi as well as in water-logged areas with thinly distributed emergent vegetation. Here they showed practically no feeding movements. In such instances they were in thickly packed flocks, the majority resting on one leg and a few on both, with the head on the back and the neck bent over the right shoulder. The flow from the feeding grounds to the resting area started from 8 a.m. and continued to 11.30 a.m. The return flight was from 3 p.m. onwards. When a resting flock was disturbed a kind of species segregation was observed in flight and on subsequent alighting. This was particularly so in *Recurvirostra avosetta, Philomachus pugnax, Pluvialis dominica,* and *Limosa limosa.*

In February when the days were rather cooler migratory waders were thinly represented. With the onset of the hot weather, by the end of February and the first week of March, there was a definite increase in the number of waders all over the area. It might be due either to fresh additions of incoming birds or just a collecting together of the birds already there as a preliminary step for their migration. It is significant that the increase in number coincided with the rise in the day temperature.

From information gathered mainly from shikaris and professional bird-catchers at different places, the following points were noted. The main wave of ducks and waders starts coming in by September, by November, when the low-lying areas are under water and the paddy crops are ripening, the peak inflow is attained. During this peak period which continues till the second week of January waders and ducks are found in enormous congregations all over the area. Then there is a sharp decline in numbers, particularly so in the case of waders. The second wave of waders (? the outward migration) starts with the onset of the hot weather, i.e. by the beginning of March. For the next $1\frac{1}{2}$ months waders are found in good numbers but not so abundantly as they were during November to January. The majority of ducks leave the place by the beginning of March and waders by the middle of April.

Alaudidae

Calandrella cinerea (Gmelin): Short-toed Lark. The first flocks were seen on 11 February. From the beginning of March the number of birds increased daily and by the second week this bird was common all over and abundant in recently ploughed fields. In certain ploughed fields they collected together during dusk for roosting in enormous numbers (? permanent roosting areas during their sojourn).

The bird is locally known as *phallak*. I was told that these birds completely disappear by the end of April and are not seen the rest of the year. I was also informed that at the time of their arrival they are thin and lean (?) and at departure are 'balls of fat'. The flesh is considered to be excellent.

A couple of hundred March individuals (18th to 22nd) showed no moulting of primaries, though in many the body feathers were in moult.

Motacillidae

The extensive alluvial plains of north Bihar provide ideal feeding ground for myriads of wagtails that visit the area during winter. Out of the five species of migrant forms that come to India, three were seen in considerable numbers:

Motacilla flava Linnaeus: Yellow Wagtail. Majority in their confusing winter (? juvenile) plumage till 18 March. A few of the subspecies *beema* and *thunbergi* were seen in breeding plumage.

Motacilla citreola Pallas: Yellowheaded Wagtail. The typical aquatic biotope wagtail. Generally met with in marshy areas.

Motacilla alba Linnaeus: White Wagtail. The majority had white ear-coverts (*dukhunensis*). I saw only five or six birds with black ear-coverts (*personata*).

None of the wagtails showed primary feather moulting, but in all the three species tail-feathers were in moult.

In winter wagtails appear to be commoner than any other bird. In the evening enormous numbers of wagtails swarmed around sugar-cane fields for roosting. Five such populous roosts were located. These very beneficial and sprightly little birds were also caught in large numbers by *Mirshikars* for sale.

Other Common Passerine Migrants

Hirundo rustica Linnaeus: Swallow. Ventral plumage was rather pure white in all individuals observed.

Lanius cristatus Linnaeus: Brown Shrike.

Acrocephalus dumetorum Blyth: Blyth's Reed Warbler.

Erithacus svecicus (Linnaeus): Bluethroat. All were the red-spotted form.

Saxicola torquata (Linnaeus): Stone Chat.

Phoenicurus ochruros (S.G. Gmelin): Black Redstart.

STATUS OF WILD LIFE

Every good area for birds had its quota of professional bird trappers. The general impression that I received is that birds and other wild life are mercilessly massacred during both the 'close' and 'open' seasons. Most people are ignorant of the game rules and no one appears interested in enforcing them. There are two types of professional bird-catchers, the *Mirshikar* operating in the whole area and the *Mallaha* operating only on large lakes like Kabar Tal and Koniya *jheel.*

Mirshikars

Mirshikars are Muslims. They are expert bird-catchers who can bag any bird; they hunt by day and by night, depending on conditions. Night trapping is done with the help of the pole net, a cotton net 9×6 ft. ($1\frac{1}{3}$ in. mesh size) loosely fastened on two cross

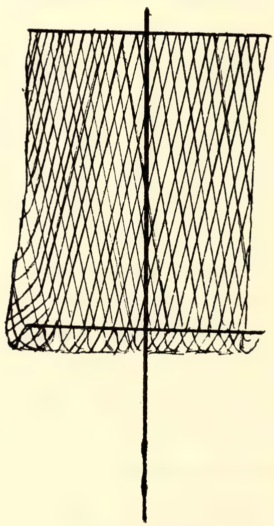

Fig. 1. Pole net

planks fixed on a main pole of 12 ft. as shown in the figure. The hunting party consists of two men. The trapper walks in front with

the pole net in one hand and a lighted bundle of dry grass in the other; the second man follows close behind beating a metal plate and carrying a basket for collection. The beating I was told is done to muffle the sound of walking. When the trapper sees a bird within 20 to 22 ft. he dashes the pole net over it—the men are such adepts that misses are rare. I saw *Anas clypeata, A. querquedula, A. crecca, Tringa glareola, Capella* sp., and *Pluvialis dominica* caught with this net. For catching waders and ducks they never go beyond knee-deep water. They do not hunt on windy nights or on moonlit nights, as the former affect the aim and the latter make the catcher visible to the bird.

'Dhubbi' type net, described by Sálim Ali (1928)[1] is also used.

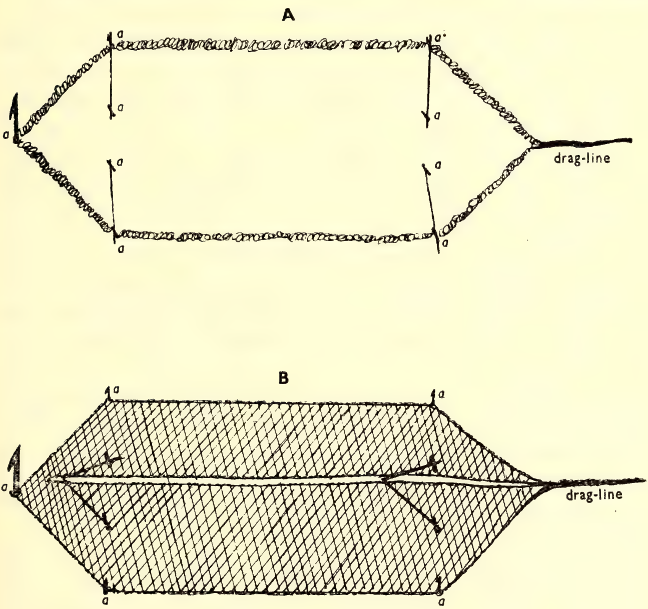

Fig. 2. "Dhubbi" net

A. 'Dhubbi' net as concealed *in situ*; B. Closed 'Dhubbi' net
a, a : Stakes

The net 25×12 ft. is biconical when stretched on the ground. One side of the net is fixed on to the ground with stakes while the other

[1] Sálim A. Ali (1928): A Sind Lake. *J. Bombay nat. Hist. Soc.* **32** (3): 460-471.

is rolled and concealed on the ground. A drag-line of 2 to 3 hundred yards is attached to the free end of the net. When this is pulled with sufficient force the rolled up portions of the net unroll and the free sides of the net on either side will come together at the centre, thereby forming a trap as shown in the figure. This net is used for large-scale catching of birds at their favourite feeding and resting grounds and is mainly used for ducks, waders, and also for short-toed larks.

Bird lime splints attached to poles and nooses are used, but the number caught by this method is considerably less.

Mallahas

Mallahas eke out a bare livelihood by catching birds and fishes. They are Hindus. Their methods of catching and handling the birds are rather crude. They catch only water birds like coots, ducks, etc., and that too only on calm pitch-dark nights. Nets and nooses are the devices used by them.

A single-tier cotton net (mesh size 2 in.) 14 to 16 ft. long and 3 to 3½ ft. wide is tied 6 to 8 ft. above water-level on bamboos fixed in water. There might be 20 to 80 nets in a single line. One group of nets requires a minimum of three men and three punts. One punt takes its position at the centre of the line of nets, 15 to 20 ft. from the net on the side opposite to where the birds are settled. At the prow of this punt an earthen pot is fixed, its rim facing away from the boat. In this pot firewood is kept burning to attract birds at the time of hunting.

Just before the hunt starts the firewood is lit. Two punts on either side of the net move forward driving the birds towards the net. When the birds reach sufficiently close a terrific uproar is set up by the boatmen on either side. Frightened birds spring from the water and some are attracted into the net by the burning firewood. Ninety-nine per cent. of the *Mallahas*' catch is got in this way.

A pole net slightly longer than the one mentioned earlier is also used. The *Mallahas*' methods with this is different from that of the *Mirshikars*. For the operation four men and three punts are required. The catcher takes his seat in the central punt and holds the pole net upright, close behind the 'pot'. Firewood in the earthen pot is lit. Punts on either side keep a distance of about 30 ft. between them and take a position 8 to 12 ft. ahead of the central punt. All the three punts move slowly keeping their respective positions, towards the place where birds are settled. When the side punts reach sufficiently

close to the birds the men raise an uproar and the disturbed birds leave the water and some attracted by the light are caught in the net.

Destruction of Birds

I spent more time at Kabar Tal than at any other place and can speak with some confidence of the distressing conditions there.

A reliable person, who is aware of the catches from Kabar over a number of years, informed me that the average daily catch of waterfowl from this lake alone comes to 4 to 5 hundred, shooting up to a thousand or more during the peak period from mid-November to the beginning of January. This would not be an exaggeration considering the strength of *Mallahas* at Kabar, a little over 900, plus about 30 *Mirshikars*. Commission agents purchase the whole catch on the spot and supply them in the adjoining towns, hence only a small fraction of the birds caught finds its way to Manjhaul bird-market. I quote below the number of birds I saw at the market as jotted down in my diary:

3 February	87	9 February	116
4 ,,	132	10 ,,	103
5 ,,	82	12 ,,	137
7 ,,	94	18 ,,	83
8 ,,	51		

On 13 and 15 February I had the opportunity of visiting *Mirshikars'* houses to have a look at their collection; the numbers noted down were 123 and 117 birds respectively. At Birpur in one day I came across six baskets of wagtails kept for sale, each containing 150 to 200 birds. I was told that the whole lot was the previous night's collection from a single roost! At Kabar I witnessed the ruthless persecution of waterfowl that goes on round the clock, during the day by shikaris with modern weapons and at night by *Mallahas* and *Mirshikars*. Snaring of birds is a full time profession in many parts of north Bihar. This in the absence of adequate sanctuaries where birds can take refuge poses a serious and challenging problem. Something needs to be done urgently and immediately, at least to restrict such wanton snaring and shooting of birds. I understand that the cruel practice of wholesale destruction of birds at lights is prohibited by law but it continues to flourish.

Destruction of water-bird habitats

Jamal Ara in her note 'In search of the Pinkheaded Duck [*Rhodonessa caryophyllacea* (Latham)]' (*J. Bombay nat. Hist. Soc.*

57 : 415-16) gives a brief account of the water-bird habitat destruction in Purnea District caused by large scale reclamation for cultivation. In recent years many *chaurs, jheels,* and other low-lying areas which were the habitat of water-birds in north Bihar have been drained. This destruction is going on at an accelerated pace depriving water-birds of their natural habitat. The prime need of the hour is to preserve some selected areas as a resort for water-birds where they can shelter from the slaughter that is rampant everywhere. Kabar Tal is a desirable spot in this respect.

Bird Migration Studies

The central portion of north Bihar offers excellent possibilities for bird migration studies both by its location in the subcontinent as well from the abundance and variety of migrants. It is possible that migrants ringed in early winter may later be recovered in other parts of the country providing information on the dispersal of the birds within the country.

The 'daylight roosts' of waders and ducks afford possibilities of large scale netting from mid-November to mid-January. Wagtails and swallows roost in enormous numbers in the area throughout the winter. As far as the Short-toed Larks are concerned large-scale ringing is possible only in the months of March and April.

Acknowledgements

I am deeply indebted to Mr. T. P. Singh, I.C.S., Development Commissioner of Bihar, whose wholehearted co-operation throughout the trip made my visit so successful; also to Mr. S. S. Sharan, I.A.S., District Magistrate of Monghyr, for constant encouragement and help. My sincere gratitude to Mr. Uma Kant Prasad, Sub-Divisional Officer of Waterways, Manjhaul, for his help in various ways, and to Mr. J. C. Kundra, I.A.S., District Magistrate of Darbhanga, and Mr. H. K. N. Iyengar, Executive Engineer, Kosi River Project, Nirmali Section. I am also thankful to the Council of Scientific and Industrial Research for the award of a Research Fellowship.

Algal Flora of Jodhpur and its environs

III. Oedogoniales[1]

BY

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[*Continued from Vol.* **61** (1) : 73]

(*With three plates*)

The present series deals with the systematic enumeration of Oedogoniales collected from Jodhpur and its environs. Two species of *Bulbochaete* and twenty of *Oedogonium* are described, out of which five are new varieties and three are new forms.

Systematic Enumeration

1. **Bulbochaete bharadwajai** Singh in Proc. Indian Acad. Sci. **8** (5) B: 395, fig. 10, D.

Dioecious; nannandrous; idioandrosporous; oogonia obovoid to subcylindric-ovoid, patent or erect, below terminal setae, poriferous, pore superior; division of the suffultory cell supreme; oospore spherical to subspherical, spore wall thick, three-layered, finely scrobiculate, androsporangia not seen; nannandria near or on oogonia or scattered on vegetative cells; antheridia exterior, 3-4.

Veg. cells 16.0-18.0 × 16.0-22.0 μ; oogonia 29.0-32.0 × 29.0-35.0 μ; oospore 22.0-26.0 × 26.0-29.0 μ; dwarf male stipe 13.0-14.0 × 16.0-19.0 μ; antheridia 7.0 × 11.0 μ; basal cell 16.25 × 22.75 μ (Plate I, fig. 13).

Habitat: Epiphytic on aquatic grasses in Akhey Raj Ji's Tank; on submerged twigs and *Chara braunii* Gmelin in Umed bund (leg. M. M. Bhandari).

2. **Bulbochaete reticulata** Nordstedt forma **tenuis** f. nov. (Plate II, figs. 36,37).

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[1] Part of the work submitted in part fulfilment for the M.Sc. Degree Examination in Botany, University of Rajasthan.

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Dioecious ; nannandrous ; gynandrosporous ; cell slender, longer than broad ; basal cells short and stout ; oogonia ellipsoidal, situated below terminal setae, vegetative cells or androsporangia ; oospore of the same shape as the oogonium and filling it completely; oospore wall thick, outer layer reticulate dentate, longitudinal anastomosing ridges, the teeth united to each other by transverse ridges ; division of suffultory cell supreme; dwarf males situated on or near the oogonia ; antheridia exterior.

Veg. cells 15.0-19.0 × 61.0-86.0 μ ; oogonia 45.0-52.0 × 76.0-82.0 μ ; oospore 35.0-39.0 × 59.0-68.0 μ ; dwarf male stipe 16.25 × 22.0-29.0 μ ; antheridium 9.0-10.0 × 11.0-13.0 μ.

Habitat : Epiphytic on aquatic plants in Kaylana (10-10-59).

The vegetative cells of this form are slightly narrower and the stipes of the dwarf males are also slightly less broad and long than those of the type. Hence it is regarded as a new form, forma *tenuis* form. nov.

Plantae dioicae, nannandrae, gynandrosporae. Cellulae vegetativae tenues, longiores quam latae ; cellulae basales breves et robustae. Oogonia ellipsoidea, posita sub setis terminalibus et cellulis vegetativis vel androsporangiis ; oosporae eiusdem formae ac oogonium idque penitus implentes. Oosporarum parietes crassi, lamina exteriore reticulato-dentata, nonnumquam costis longitudinalibus anastomosantibus, dentibus inter se unitis per juga transversa. Cellularum suffulcientium divisio suprema ; mares nani oogoniis insidentes vel prope ea positi ; antheridia externa.

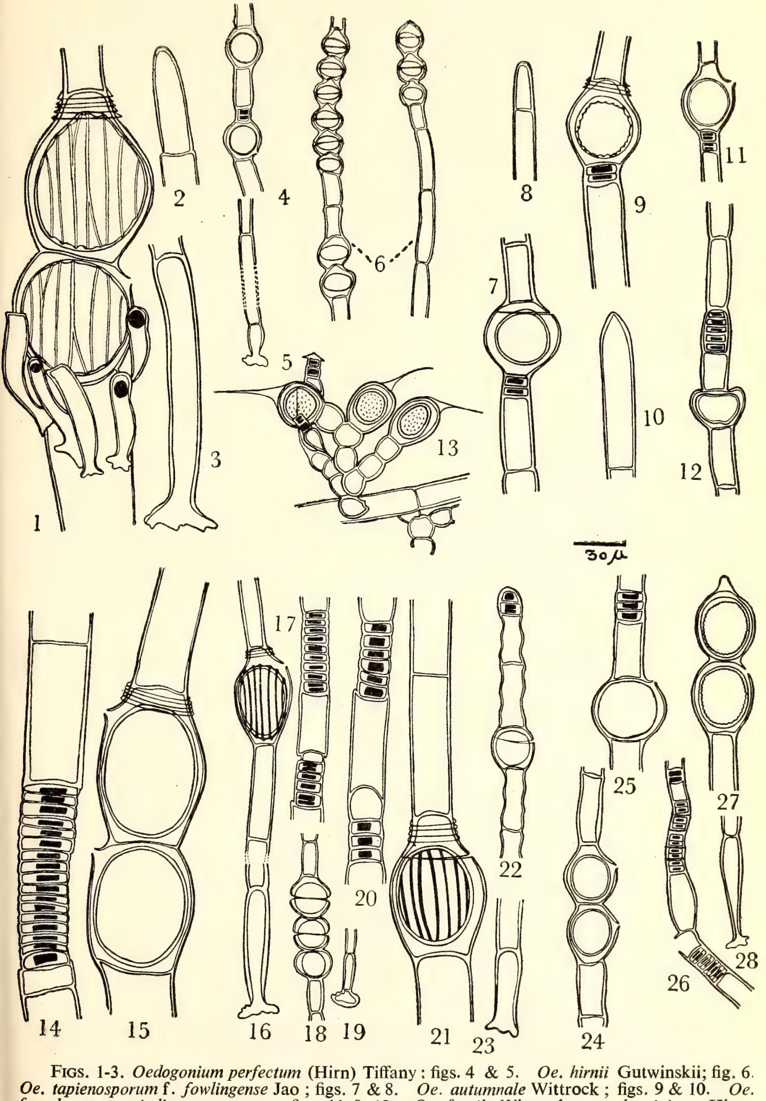
Typus : *JB* 2, Algal Laboratory, Indian Agricultural Research Institute, New Delhi-12.

3. **Oedogonium croasdaleae** Jao var. **kaylanaense** var. nov. (Plate II, figs. 29-31).

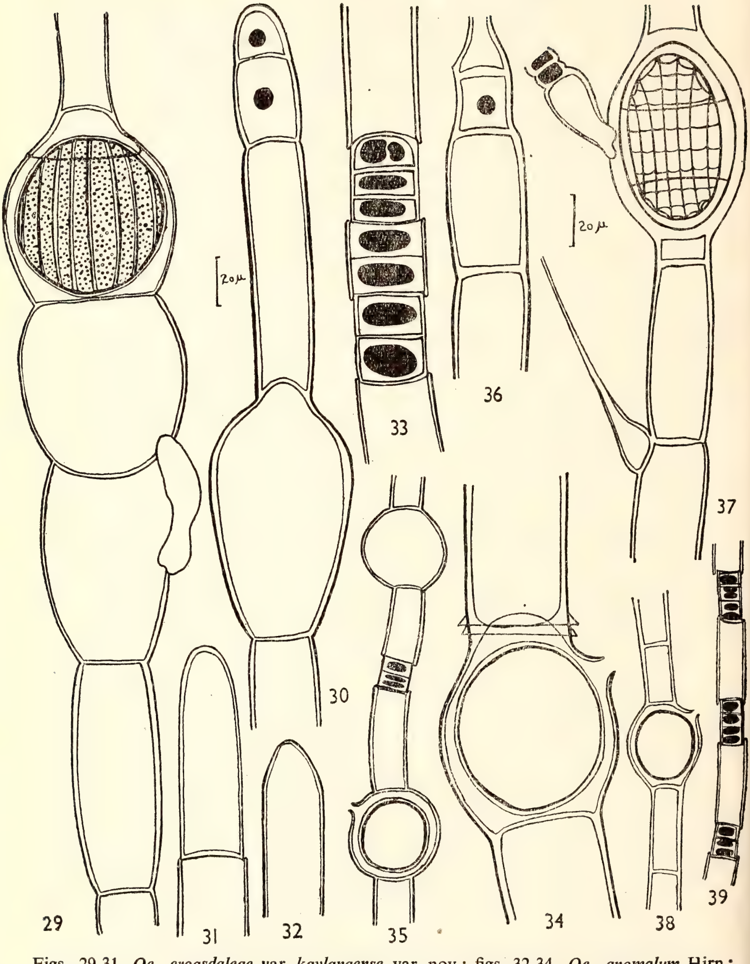
Dioecious ; nannandrous ; gynandrosporous ; vegetative cells cylindric ; oogonia 1-6 sometimes 10 seriate ; oogonia terminal or intercalary, subobovoid to quadrangular-ellipsoid, operculate, division superior ; oospores of the same form as the oogonia, filling the oogonium, spore wall of three layers, outer smooth, middle layer thick with 16-32 not anastomosing longitudinal ribs, inner spore wall granulate ; suffultory cells tumid ; androsporangia 1-8 seriate, epigynous, rarely hypogynous or subhypogynous ; dwarf males goblet-shaped, on the suffultory cell, occasionally on the oogonia ; antheridia inferior ; filaments tapering towards the base ; apical cell obtuse, often an oogonium or androsporangium ; basal cell elongate.

Veg. cell 26.6-34.2 × 156.0 μ ; oogonia 57.0-72.2 × 53.2-76.0 μ ; oospores 53.2-68.4 × 49.4-72.2 μ ; androsporangia 22.8-26.6-34.2 μ ; dwarf males 19.0-22.8 × 38.0-57.0 μ.

Plantae dioicae, nannandrae, gynandrosporae, cellulae vegetativae



FIGS. 1-3. *Oedogonium perfectum* (Hirn) Tiffany; figs. 4 & 5. *Oe. hirnii* Gutwinskii; fig. 6. *Oe. tapienosporum* f. *fowlingense* Jao; figs. 7 & 8. *Oe. autumnale* Wittrock; figs. 9 & 10. *Oe. foveolarum* var. *indicum* var. nov.; figs. 11 & 12. *Oe. fragile* Wittrock var. *abyssinicum* Hirn; fig. 13. *Bulbochaete bharadwajai* Singh; figs. 14 & 15. *Oe. crassum* (Hassal) Wittrock f. *indica* form. nov.; figs. 16 & 17. *Oe. exocostatum* var. *jodhpurense* var. nov.; figs. 18 & 19. *Oe. howardii* West; figs. 20 & 21. *Oe. paucicostatum* var. *unispermum* var. nov.; figs. 22 & 23. *Oe. nodulosum* var. *tenue* var. nov.; figs. 24 & 25. *Oe. plagiostomum* Wittrock f. *indicum* form. nov.; figs. 26-28. *Oe. punctatum* Wittrock



Figs. 29-31. *Oe. croasdaleae* var. *kaylanaense* var. nov.; figs. 32-34. *Oe. anomalum* Hirn; fig. 35. *Oe. intermedium*; figs. 36 & 37. *Bulbochaete reticulata* Nord. f. *tenuis* form. nov.; figs. 38 & 39. *Oe. varians* Wittr. & Lund.

cylindricae ; oogonium vulgo unicum, raro duplex, usque decem tamen notata sed rarissime. Oogonia vulgo apicalia vel intercalaria, quadrangularia vel subovata vel ellipsoidea vel subellipsoidea, operculata, divisione superiore. Oosporae eiusdem formae ac oogonium idque non penitus implentes. Sporarum parietes lamina triplici constantes, quarum exterior levis, media vero crassa ornata 16-32 costis longitudinalibus anastomosantibus irregulariter undulatis, pulchre granulata in depressione ; cellulae suffulcientes tumidae ; androsporangia usque 8-seriata, epigyna, raro hypogyna vel subhypogyna ; mares nani scyphiformes, curvati super cellulam suffulcientem, nonnumquam super oogonia ; antheridia interiora ; filamenta fastigata ad basim ; cellula apicalis obtusa, saepe in antheridium vel oogonium mutata, cellula basalis elongata.

Habitat : From Kaylana, epiphytic on aquatic plants along with *Bulbochaete reticulata* forma *tenuis* f. nov. (10-10-59).

Typus : *JOe* 3, Algal Laboratory, Indian Agricultural Research Institute, New Delhi-12.

This form should be compared with *Oe. croasdaleae* Jao, with which it agrees in having granulate inner spore wall and nannandrous and gynandrosporous habit. However it differs from the same in having non-anastomosing longitudinal ribs, shorter oogonia and oospores and broader nannandria. It also resembles the members of the ' cyathigerum ' and ' wolleanum ' group, but can be clearly distinguished by its operculate character and granulate innerspore wall. Hence it is regarded as a new variety, var. *kaylanaense* var. nov.

4. **Oedogonium perfectum** (Hirn) Tiffany in Ohio J. Sci. **34** : 326, 1934. *Oe. cyathigerum* Wittrock f. *perfectum* Hirn in Acta Soc. Sci. Fenn. **27** : 254, t. 63.

Dioecious, nannandrous, idioandrosporous ; oogonia intercalary, occurring singly or in pairs, rarely in threes, globose or subovoid to ellipsoid, poriferous, division superior ; oospores of the same shape as oogonia, more or less completely filling the oogonia, outer wall smooth, middle wall with 20 to 32 anastomosing ribs, inner wall smooth ; androsporangia rare ; dwarf males goblet shaped, elongate or curved, usually on the suffultory cell, rarely on the oogonia ; suffultory cell swollen ; apical cell obtuse ; vegetative cells cylindric ; antheridium interior.

Veg. cells (19.0) 22.8-41.8 $\times$ 130.0-277.5 μ ; oogonium 76.0-95.0 $\times$ 72.0-76.0 μ ; oospore 68.25-72.2 $\times$ 72.2-94.25 μ ; androsporangia 26.6 $\times$ 28.5 μ ; nannandria 15.0-18.0 $\times$ 72.2-98.8 μ ; suffultory cell 53.2-57.0 $\times$ 91.2-95.0 μ ; basal cell 22.8 $\times$ 159.6 μ (Plate I, figs. 1-3).

Habitat : From a small pond near Motikund ; epiphytic on aquatic plants (6-12-52) (leg. M. M. Bhandari).

5. **Oedogonium anomalum** Hirn. Tiffany in Trans. Amer. Micros. Soc. **45** (2) : 91, figs. 6 and 7, 1926.

Dioecious; macrandrous; vegetative cells cylindrical; oogonia solitary, rarely in pairs, cylindric ovoid, poriferous, division superior; oospore globose or subglobose, spore wall smooth; antheridia in series of 5-10, sperm 2, division vertical; apical cell obtuse.

Female Veg. cell 30.4-38.0 × 144.4-228.0 μ; male veg. cell 26.6-30.4 × 144.4-155.8 μ; oogonia 64.6-72.2 × 91.2-106.4 μ; oospore 53.2-60.8 × 68.4-76.0 μ; antheridia 30.4-34.2 × 13.3-19.0 μ (Plate II, figs. 32-34).

Habitat: From Takhatsagar (15-10-59).

6. **Oedogonium crassum** (Hassall) Wittrock forma **indica** f. nov. (Plate I, figs. 14, 15).

Dioecious; macrandrous; vegetative cells cylindric; oogonia solitary or in pairs, when in pairs one of them is shorter, rarely three, ovoid to suboblong ellipsoid, poriferous, division superior; oospores ellipsoid to ellipsoid globose, may or may not completely fill the oogonia, spore wall thin and smooth; antheridia 2-25, sperms 2, division vertical; suffultory cell not swollen; basal cell elongate.

Female veg. cell 35.75-40.75 × 126.75-179.0 μ; male veg. cell 45.50-52.0 × 104.0-130.0 μ; oogonia (81.25) 71.50-82.0 × 104.0-130.0 μ; oospores 68.25-71.50 × 68.25-97.50 μ; antheridium 6.50-9.75 × 32.50-35.75 μ.

Plantae dioicae, macrandrae, robustae; cellulae vegetativae cylindricae; oogonia vulgo singula vel bina, tunc vero alterum altero longius, vel rarius terna, ovoidea vel suboblongo-ellipsoidea, porifera, poro superiore; oosporae ellipsoideae vel ellipsoideo-globosae, oogonium fere implentes, rarissime globosae nec implentes oogonium; sporarum parietes tenues et leves; antheridia 2-25 numero, spermatibus binis, divisione verticali; cellulae suffulcientes haud tumescentes, basalis vero elongata.

Habitat: From Kaylana as epiphytic (28-8-59) and from Akhey Raj Ji's Tank, epiphytic on *Vallisneria spiralis* Linn. (14-1-60).

Typus: *JOe* 6, Algal Laboratory, Indian Agricultural Research Institute, New Delhi-12.

The alga can be compared with *Oe. ellipsosporum* Singh, but differs greatly in the dimensions. The alga comes very near *Oe. crassum* (Hass.) Wittrock in all of its characters, but differs in broader and shorter vegetative cells, shorter antheridia and slightly bigger oogonia and much shorter female vegetative cells. It can be compared with *Oe. crassum* f. *amplum* (Magnus & Wille) Hirn in its smaller dimensions of female vegetative cells and nearly the same dimensions of oogonia and oospores, but differs from it in shorter dimensions of male

vegetative cells and antheridia. It resembles var. *subtumidum* Hirn in the dimensions of oogonia, oospores and nearly the same size of the antheridia, but differs in the dimensions of the vegetative cells. It is, therefore, treated as a new form, forma *indicum* f. nov.

7. **Oedogonium exocostatum** var. **jodhpurense** var. nov. (Plate I, figs. 16, 17).

Dioecious; macrandrous; vegetative cells cylindric, basal cell elongate; oogonium ellipsoid to ellipsoid-globose, solitary rarely in pairs, poriferous divisions superior, always intercalary sometimes apical also; oospores oval or ellipsoid, nearly filling the oogonia, oospore wall of two layers, outer wall with 13-15 longitudinal ribs with entire margin, inner layer smooth; suffultory cell not swollen; antheridia 3-7, sperms two, division horizontal.

Female veg. cells 19.50-26.0 × 42.25-71.0 μ; male veg. cells 11.0-13.0 × 43.25-48.0 μ; oogonia 42.25-48.75 × 55.25-71.30 μ; oospore 42.25 × 48.75-52.0 μ; antheridium 13.0-14.0 × 5.0-7.0 μ.

Dioicae, macrandrae, cellulae vegetativae cylindricae; cellulae basales elongatae; oogonium ellipsoideum vel ellipsoideo-globosum, unum, raro duo, poriferum, poro superiore, intercalare, nonnumquam terminale; oosporae ovales vel ellipsoideae, fere implentes oogonium vel ut plurimum nequaquam; parietes bis laminati, lamina exteriore distincta 13-15 costis longitudinalibus marginibus levibus, lamina interiore levi; cellulae suffulcientes non tumescentes; antheridia (3-7), spermata bina, divisione horizontali.

Habitat: Epiphytic on submerged plants of *Cynodon dactylon* Pers. along with *Oe. fragile* var. *abyssinicum* Hirn at Kaylana (10-10-52) (leg. M. M. Bhandari); from Akhey Raj Ji's Tank, heavily infested with *Uronema indica* Ghose, (10-10-59).

Typus: *JOe* 7, Algal Laboratory, Indian Agricultural Research Institute, New Delhi-12.

This form agrees with the type in the structure of spore wall, but differs in having unswollen suffultory cell, shorter vegetative cells and smaller oospores. Hence it is regarded as a new variety, var. *jodhpurense* var. nov.

8. **Oedogonium dioicum** Carter (?) Tiffany 1930, p. 107, Pl. 37, figs. 356 and 357.

Dioecious; macrandrous; oogonia solitary, operculate, division superior, globose to subovoid; oospore globose to oval or ellipsoid, thin and smooth oospore wall, not filling the oogonium; male filaments slightly smaller than the females; antheridia in series of 5-10, sperms two, division vertical.

Female veg. cell 30.4-32.3 × 83.6-114.0 μ; male veg. cell 24.7-26.6 × 114.0-121.6 μ; oogonia (57.0) 60.8-64.6 × (64.6) 76.0-83.6 μ;

oospore 45.6-60.8 × (45.6) 64.6-72.2 μ ; antheridium 22.8-26.6 × 7.6-11.4 μ (Plate III, figs. 40 & 41).

Habitat: From Akhey Raj Ji's Tank (10-10-59).

9. **Oedogonium howardii** West. Tiffany 1930, p. 101, pl. 33, fig. 293 ; Singh in Proc. Indian Acad. Sci. **8** (5) B : 389 ; Venkataraman et Natrajan in Proc. Nat. Inst. Sci. India **26 B** : 15, 1960.

Dioecious ; macrandrous ; vegetative cells broadly capitellate ; oogonia 1-4, globose or pyriform globose, operculate, operculum medium ; oospore globose or subdepressed globose, nearly filling the oogonia, wall smooth ; antheridia 1-16 ; basal cell sub-hemispherical, never elongate ; male filaments slightly broader than the females.

Female veg. cells 7.5-11.0 × 22.75-39.0 μ ; male veg. cells 8.5-12.0 × 23.0-40.6 μ ; oogonium 26.0-32.5 × 26.0-32.5 μ ; oospore 22.75-25.0 × 26.0-32.0 μ ; antheridia 7.6-9.5 × 9.5-13.3 μ (Plate I, figs. 18 & 19).

Habitat: From Akhey Raj Ji's Tank as epiphytic (9-8-59).

10. **Oedogonium pringsheimii** (Crammer) Wittrock. Tiffany, 1930, p. 107, pl. 35, figs. 325 and 326.

Dioecious ; macrandrous ; oogonia solitary or in pairs, globose depressed globose, operculate, operculum superior ; oospore globose, nearly filling the oogonium, spore wall smooth ; antheridia 1-5, intercalary, sometimes apical, alternating with vegetative cells, sperms 2, division horizontal ; terminal cell obtuse ; male filaments are little smaller than the females.

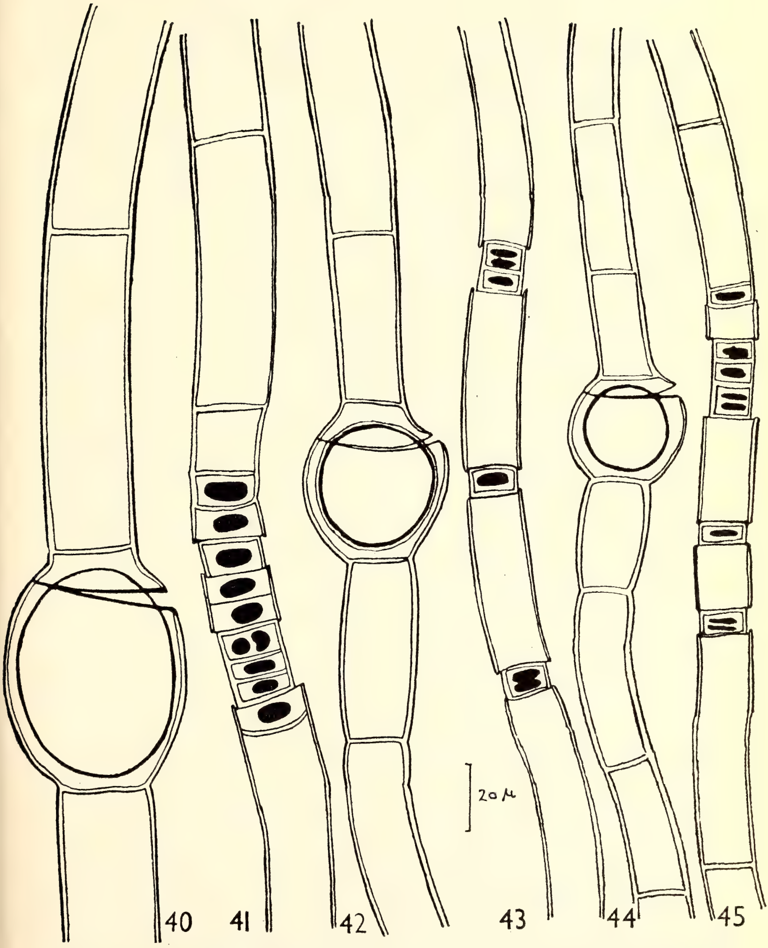
Female veg. cell 19.0-22.8 × 38.0-45.6 μ ; male veg. cell 15.2-17.1 × 34.2-41.8 μ ; oogonium 38.0-45.6 × 34.2-38.0 μ ; oospore 34.2-41.8 × 30.4-34.2 μ ; antheridia 15.2-17.1 × 5.7-7.6μ (Plate III, figs. 44 & 45).

Habitat: From Bheem Bharak near Jodhpur (10-9-59).

11. **Oedogonium punctatum** Wittrock. Tiffany 1930, p. 96. pl. 29, figs. 255-256.

Dioecious ; macrandrous ; vegetative cells cylindric ; oogonia usually solitary, sometimes in pairs, obovoid to globose obovoid, poriferous, pore superior ; oospore obovoid, more or less completely filling the oogonia, outer spore wall finely scrobiculate ; antheridia 1-5, often alternating with the vegetative cells, sperms 2, division horizontal ; basal cell elongate ; terminal cell often an oogonium or obtuse ; suffultory cell not swollen.

Female veg. cell 13.0-22.75 × 39.0-87.75 μ ; male veg. cells 9.75-14.50 × 52.5-65.0 μ ; oogonia 39.0-43.75 × 42.25-45.50 μ ; oospore 39.0-42.25 × 39.0-45.50 μ ; antheridia 11.50-13.0 × 6.0-10.0 μ (Plate I, figs. 26-28).



Figs. 40 & 41. *Oe. dioicum* Carter (?); figs. 42 & 43. *Oe. welwitschii* West; figs. 44 & 45. *Oe. pringshiemii* (Crammer) Wittr.

Habitat: From Motikund epiphytic on aquatic plants (26-8-52) (leg. M. M. Bhandari).

12. **Oedogonium paucicostatum** Transeau var. **unispermum** var. nov. (Plate I, figs. 20 & 21).

Dioecious; macrandrous; vegetative cells cylindric; oogonia solitary, ellipsoidal, operculate, division superior; oospore globose to ellipsoid nearly filling the oogonia, outer wall smooth, medium wall longitudinally ribbed, ribs 15-17, inner wall smooth; antheridia 1-6, sperm one; terminal cell obtuse; basal cell elongate.

Female veg. cells (19.0) 22.8-30.4 × 40.0-65.0 μ; male veg. cells 19.50-32.50 × 68.25-143.0 μ; oogonia 61.75-65.0 × 78.0-81.0 μ; oospore 49.4-60.8 × 14.22-50.0 μ; antheridia 22.75-29.25 × 14.22 μ.

Plantae dioicae, macrandrae; cellulae vegetativae cylindricae; oogonium unicum, ellipsoideum, operculatum, divisione superiore; oosporae globosae vel ellipsoideae, oogonium fere implentes; parietes exteriores leves, medii vero longitudinaliter costati costis 15-17 longitudinalibus; interiores parietes leves; antheridia 1-6, rarius 7, spermata singula, cellula terminalis obtusa, cellula basalis elongata.

Habitat: From Kaylana; free floating (21-10-59).

Typus:—*JOe* 12, Algal Laboratory, Indian Agricultural Research Institute, New Delhi-12.

The alga by its superior pore and longitudinally ribbed middle wall of the oospore comes very near to *Oedogonium paucicostatum* Trans. It further agrees with the same in the shape and the number of antheridia, but it differs from the type, in the nature of antheridia. There is only a single sperm in the present material, whereas in the type the antheridium has two sperms and the division is horizontal. It further differs from the type in its shorter vegetative cells and smaller oogonia; the shape of the oogonia is also variable. The antheridia are much larger than those of the type. It is, therefore, treated as a new variety, var. *unispermum* var. nov.

13. **Oedogonium plagiostomum** Wittrock forma **minuta** f. nov. (Plate I, figs. 24 & 25).

Dioecious; macrandrous; vegetative cells cylindric; oogonia solitary, sometimes in pairs, globose or ovate, poriferous, division superior; oospore globose or subglobose, not filling the oogonia, wall smooth; antheridia not found; basal cell elongate; terminal cell either oogonium or broadly truncate; suffultory cells sometimes swollen.

Veg. cells 9.75-19.0 × 39.0-68.25 μ; oogonia 35.75-39.0 × 39.0-48.75 μ; oospore 39.0 × 39.0 μ.

Plantae dioicae; macrandrae; cellulae vegetativae cylindricae; oogonia solitaria vel nonnumquam bina, ovato-globosa, porifera,

poro superiore; oosporae globosae vel subglobosae, oogonium haud penitus implentes; parietes leves; antheridia haud visibilia; cellula basalis elongata, cellula terminalis vel oogonium vel late truncata; cellulae suffulcientes nonnumquam tumescentes.

Habitat: Collected along with *Oedogonium nodulosum* var. *tenue* var. nov.

Typus: *JOe* 13, Algal Laboratory, Indian Agricultural Research Institute, New Delhi-12.

It agrees with *Oedogonium plagiostomum* in all respects except in having narrower filaments and narrow and shorter oogonia. The dimensions of the material differ from *Oe. plagiostomum* Wittrock described by Carter (1926) and Venkataraman (1959). Hence it is regarded as a smaller form of *Oe. plagiostomum* forma *minuta* f. nov.

14. **Oedogonium tapeinosporum** f. **fowlingense** Jao in Sinnesia **8**: 299-313, 1937. Venkataraman in J. Bombay nat. Hist. Soc. **56**: 63-63, fig. 9.

Dioecious; macrandrous; vegetative cells cylindric; oogonia 1-6, pyriform to pyriform-globose or depressed-globose, operculate, division median, oospore depressed-globose, not filling the oogonia, spore wall smooth; terminal cell often an oogonium antheridia not seen; vegetative cells capitellate.

Veg. cells 7.50-8.25 × 22.75-29.0 μ; oogonia 19.50-21.0 × 19.50-22.75 μ; oospore 17.0-18.0 × 11.0-15.0 μ (Plate I, fig. 6).

Habitat: Collected along with *Bulbochaete reticulata* forma *tenuis* f. nov. from Kaylana (10-10-59).

15. **Oedogonium varians** Wittrock et Lundell. Tiffany 1930, p. 69, pl. 12, fig. 120.

Dioecious; macrandrous; oogonia solitary, globose, depressed-globose or pyriform-globose, poriferous, division superior; oospore globose, wall smooth; antheridia 1-4, alternating with vegetative cells, sperms 2, division horizontal; vegetative cells cylindrical.

Female veg. cells 11.4-15.2 × 34.2-41.8 μ; male veg. cells 11.4-15.2 × 30.4-41.8 μ; oogonia 32.3-38.0 × 26.6-45.6 μ; oospore 30.4-34.2 × 30.4-34.2 μ; antheridia 9.5-15.2 × 3.8-7.6 μ (Plate II, figs. 38 and 39).

Habitat: Floating at Balsamand gardens (27-10-59) and Maghraj Ji's ka Tanka on Mandore Road (27-10-59).

16. **Oedogonium welwitschii** West & West. Tiffany 1930, pl. 37, figs. 351-352.

Dioecious; macrandrous; vegetative cells cylindrical; oogonia solitary, globose to depressed globose, operculate, operculum superior; oospore globose, wall smooth; antheridia 1-3, sperms 2, division horizontal.

Female veg. cell 19.0-22.8 × 76.0-87.4 μ ; male veg. cells 17.1-19.1 × 45.6-68.4 μ ; oogonia 45.6-49.4 × 45.6-51.3 μ ; oospore 41.8-43.5 × 39.9-41.8 μ ; antheridia 11.4-15.2 × 7.6-11.4 μ (Plate III, figs. 42 & 43).

Habitat : From a pool near Lalsagar (29-9-59).

17. **Oedogonium autumnale** Wittrock. Tiffany 1930, p. 112, pl. 36, fig. 341.

Monoecious ; macrandrous ; vegetative cells cylindric ; oogonia solitary, globose or obovoid globose, operculate, division superior ; oospores bright yellow, globose, not completely filling the oogonia, spore wall thick and smooth ; antheridia 1-2, subepigynous, hypogynous or scattered, sperms 2, division horizontal ; terminal cell acute.

Veg. cell 17.75-22.75 ×48.75-74.75 μ ; oogonia 48.75-55.25 × 45.50-55.25 μ ; oospore 39.0-42.25-39.0-42.25 μ ; antheridia 17.0 × 5.50-9.0 μ (Plate I, figs. 7 & 8).

Habitat : From Lalsagar (10-10-52) (leg. M. M. Bhandari), and from Balsamand gardens along with *Oedogonium fragile* var. *abyssinicum* Hirn (14-10-59).

18. **Oedogonium foveolarum** Wittrock var. **indicum** var. nov. (Plate I, figs. 9 & 10).

Monoecious ; macrandrous ; vegetative cells cylindric ; oogonia solitary or in pairs, globose to subglobose, poriferous, pore superior ; oospore globose to subellipsoid-globose, filling or not filling the oogonium, spore wall two layered, inner smooth, outer scrobiculate ; antheridia 1-2 epigynous, hypogynous or scattered, sperms 2, division horizontal ; basal cell elongate ; terminal cell obtuse or an antheridium.

Veg. cell 16.25-26.0 × 61.75-97.50 μ ; oogonia 48.75-65.0 × 53.0-61.75 μ; oospore 42.25-47.50 × 42.25-45.50 μ ; antheridia 19.50-22.75 × 4.75-9.75 μ.

Plantae monoicae, macrandrae ; cellulae vegetativae cylindricae ; oogonia singula vel bina, globosa vel subglobosa porifera, poro superiore ; oosporae globosae vel subellipsoideo-globosae implentes oogonium vel secus ; parietes bis laminati, lamina exteriore levi, interiore vero scrobiculata ; antheridia singula vel bina, epigyna, hypogyna vel dispersa, spermatibus binis, divisione horizontali, cellula basali elongata, terminali vero apicaliter obtusa vel vulgo in antheridium mutata.

Habitat : Along with *Oedogonium nodulosum* var. *tenue* var. nov., *Schizemeris irregularis,* and *Ulothrix zonata* (Weber and Mohr) Kutz. from Mandore (14-10-59).

Typus : *JOe* 18, Algal Laboratory, Indian Agricultural Research Institute, New Delhi-12.

This alga differs from the type in having scrobiculate inner spore wall while in the type the outer wall is scrobiculate. Hence it is regarded as a new variety, var. *indicum* var. nov.

19. **Oedogonium fragile** var. **abyssinicum** Hirn. Tiffany 1930, p. 75, pl. 15, fig. 145.

Monoecious; macrandrous; vegetative cells cylindric, lateral walls slightly convex; oogonia solitary or in pairs, globose to pyriform-globose, poriferous, division superior; oospore globose to pyriform globose, usually not completely filling the oogonium, spore wall smooth; antheridia 1-2, epigynous, hypogynous, sometimes subepigynous; sperms 2, division horizontal; basal cell elongate.

Veg. cell 16.0-19.0 × 26.0-51.0 μ; oogonia 39.0-45.0 × 40.0-55.0 μ; oospore 39.0-42.0 × 42.0-48.0 μ; antheridium 14.50-16.25 × 9.50-11.0 μ (Plate I, figs. 11 & 12).

Habitat: From Akhey Raj Ji's Tank (14-10-59) and from Kaylana (10-10-52) (leg. M. M. Bhandari).

20. **Oedogonium hirnii** Gutwinskii. Tiffany 1930, p. 73, pl. 14, figs. 136-137.

Monoecious; macrandrous; vegetative cells capitellate; oogonia solitary, globose, poriferous, pore superior; oospore globose or ovoid globose, filling the oogonium or not, spore wall smooth; antheridia epigynous or subepigynous, sperms 2, division horizontal; basal cells elongate.

Veg. cell 9.0-10.0 × 29.25-39.0 μ; oogonia 22.75-29.25 × 26.0-32.50 μ; oospore 19.0-26.0 × 22.0-28.0 μ; antheridia 4.50 × 7.50 μ (Plate I, figs. 4 & 5).

Habitat: Epiphytic on *Vallisneria spiralis* Linn. at Akhey Raj Ji's Tank.

21. **Oedogonium intermedium** Wittrock. Tiffany 1930, p. 72, pl. 14, fig. 134.

Monoecious; macrandrous; vegetative cells cylindrical; oogonia solitary, globose to depressed globose, poriferous, division superior, oospore globose or obovoid globose nearly filling the oogonium, spore wall thick and smooth, light brown in colour; antheridia 1-4, sperms 2, division horizontal, epigynous or subepigynous.

Veg. cells 15.2-19.0 × 38.0-41.8 μ; oogonia 38.0-41.8 × 34.2-45.6 μ; oospore 34.2-37.4 × 34.2-37.4 μ; antheridia 11.4-13.3 × 3.8-5.7 μ.

Habitat: From Panch Kund near Mandore as free floating (29-10-59).

22. **Oedogonium nodulosum** var. **tenue** var. nov. (Plate I, figs. 22 & 23).

Monoecious; macrandrous; vegetative cells undulate with three undulations, sometimes cylindrical capitellate; basal cell elongate; oogonia solitary, sub-globose to sub-depressed-globose, operculate, operculum superior; oospore sub-depressed to depressed-globose nearly filling the oogonium, wall smooth and thick antheridia 1-2 seriate, sperms 2, division horizontal, apical cell usually obtuse, sometimes apiculate or an antheridium.

Veg. cell 16.30-22.82 × 26.08-52.16 μ ; oogonia 32.6-38.88 × 26.08-35.86 μ ; oospore 19.6-32.6 × 22.82-32.6 μ ; antheridia 15.0 × 4.76-6.52 μ ; basal cell 15.0-16.30 × 52.16-55.42 μ.

Plantae monoicae, macrandrae ; cellulae vegetativae capitellatae, nonnumquam nodulosae ; cellula basalis elongata ; oogonia singula, subpyriformia vel subdepresso-globosa, operculata ; divisione supramedia. Oosporae subdepressae vel depresso-globosae, fere implentes oogonium ; parietes sporarum leves ; antheridia 1-3 seriata, subepigyna vel dispersa ; spermata bina, divisio horizontalis, vulgo cellula apicalis est obtusa, sed aliquando est apiculata.

Habitat : From Akhey Raj Ji's Tank (15-10-59).

Typus : *JOe* 25, Algal Laboratory, Agricultural Research Institute, New Delhi-12.

This form differs from the type in smaller dimensions. It also differs in having sometimes cylindrical capitellate cells scattered between undulate veg. cells. This form should, however, be compared with *Oe. sphaerandrium* from which it differs in having elongate basal cell, solitary oogonia, formation of two sperms in each antheridium, absence of pyriform apical cell and having bigger dimensions. Hence it is regarded as a new variety, var. *tenue* var. nov.

Acknowledgements

The author is grateful to Messrs. R. M. Bhandari and M. M. Bhandari of Jaswant College, Jodhpur, Rajasthan, for their guidance ; to Dr. G. S. Venkataraman of Indian Agricultural Research Institute, New Delhi-12, for advice and to Rev. Fr. H. Santapau for kindly translating the new taxa into Latin.

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Some Observations on the Fauna of the Maldive Islands

Part VII—BUTTERFLIES

BY

W. W. A. PHILLIPS

[*Continued from Vol.* **55** (3): 492]

This short paper is the outcome of two visits paid by the author and his wife to the Maldive Islands, the first to North Malé Atoll from the end of November 1956 to early February 1957 and the second to Addu Atoll in the extreme south of the archipelago from the end of May 1958 to the beginning of April 1959. On both these visits we were accompanied by a retired Colombo Museum collector and taxidermist, William Perera, who always carried a butterfly-net whenever we went out and who, when not otherwise engaged, devoted much of his time to collecting specimens of the local lepidoptera and other insects. The main objective of our activities was a study of the vertebrate fauna of the archipelago (see Parts I-V of this series, Vol. **55**) so the collection of lepidoptera and insects was, unavoidably, of secondary importance. Even so, numerous specimens were collected and some notes were made.

The first collection, from North Malé Atoll, was sent to the British Museum (Natural History) on our return to England in 1957, but the specimens collected in Addu Atoll were forwarded by post, through the Field Post Office on Gan, direct to the Museum, from time to time as the specimens were collected, for the hot and humid climatic conditions that prevail in Addu Atoll made it inadvisable to keep them longer than was necessary in such a climate.

The specimens were identified through the kindness of Mr. N. D. Riley, former Keeper of Entomology at the Museum, and Mr. T. G. Howarth and I am now able to give an annotated list of the butterflies collected. I have added a few brief remarks under each species where necessary. My grateful thanks are due to Mr. Riley and to Mr. Howarth for their assistance.

It is interesting to note that, while 25 species were collected in North Malé Atoll (approx. 73° 30′ E. 4° 30′ N., near the centre of the archipelago) and several others were seen but evaded capture, a more prolonged and thorough search in Addu Atoll (the southernmost atoll of

the group, lying some 30 miles south of the Equator) revealed only 7 species in that atoll. This fact tends to confirm the belief that the butterfly fauna of the Maldives decreases rapidly as one proceeds southwards, many more species and many more individuals being found in the northern atolls than in the southern.

So closely are the Maldivian butterflies related to those of south India and Ceylon[1] that it has proved impossible to differentiate between them, thus indicating (as isolation has so far failed to evolve any new forms) that the influx of butterflies into the Maldives is of comparatively recent origin and that all the species now found in the Maldives have originated either in south India or in Ceylon. It seems very probable, if not certain, that the majority of them owe their fortuitous presence in the Maldives to the winds and gales of the NE. Monsoon which have assisted their passage across the intervening seas. Some of them may, however, have moved southwards, from atoll to atoll, through the Laccadives into the Maldives and on southwards to Addu Atoll.

That some species do, in fact, fly the seas that divide the Maldives from Ceylon, even when the winds are light, is confirmed by the sighting of a large, strong-flying Papilionid (probably *Atrophaneura* sp.) flying westwards close over the seas at 15.55 hrs. in the afternoon of 28 November 1956 when our vessel, the *Max Arlt*, was still some 200 miles east of Malé, the nearest land. Other swallow-tails were sighted, later in the visit, flying strongly over the lagoons, from island to island.

For a description of the Maldivian Archipelago reference should be made to the first paper of this series.

ANNOTATED CHECKLIST OF MALDIVIAN BUTTERFLIES, LEPIDOPTERA, RHOPALOCERA

Family: SATYRIDAE

3 species taken in North Malé Atoll but the family is not represented in Addu Atoll. One species, *Culapa mineus polydecta*, taken by Gardner, was not seen by me.

Melanitis leda ismene C.: The Common Evening Brown

Moderately plentiful in North Malé Atoll (especially in Malé) but absent from Addu. Frequent in gardens and compounds in the evenings. Females appear to be more plentiful than males; of 14 of the dry season form, 4 were males and 10 were females, but of the wet season form 2 were males and only one a female.

[1] All the species and subspecies included in the list occur in south India and Ceylon.—EDS.

Orsotriaena medus mandata M. : The Nigger

Very plentiful in North Malé Atoll but absent from Addu. A common species amongst the scrub and lush vegetation around the swamps on Hulule and Willingilli Islands but rare on Malé Island. Males greatly outnumber females.

Culapa (Mycalesis) visala subdita M. : The Tamil Bush-Brown

Rare. 2 males, only, were taken on Malé. Not seen in Addu.

Family : DANAIDAE

2 species were taken in North Malé Atoll, one of which was also found in Addu. One species, *Euploea sylvester montana*, recorded by Gardner, was not met with by me.

Danaus chrysippus chrysippus L. : The Plain Tiger

Widespread but rather scarce. A male and 4 females were taken in North Malé and a further 12 in Addu Atoll.

Danaus limniace leopardus B. (=*mutina* F.) : The Blue Tiger

Rare. A single female was taken in North Malé Atoll, possibly a wind-driven wanderer from south India.

Family : NYMPHALIDAE

5 species were taken in North Malé Atoll, 3 of which were common to that atoll and to Addu. At least one other species was seen but evaded capture in Malé.

Acraea (Telchinia) violae F. : The Tawny Coster

Rare. 2 females were taken in open grassland on Hulule Island, close to Malé, in North Malé Atoll. Not found in Addu.

Vanessa cardui L.: The Painted Lady

3 females, all rather worn, were taken in North Malé Atoll but, during September and October (1958) many fresh specimens were observed in the grassy areas of Gan, in Addu Atoll. The species appeared to be widespread in the Maldives and to be moderately plentiful at certain times of the year.

Hypolimnas misippus L. : The Danaid Eggfly

Rather uncommon in North Malé Atoll but more plentiful in Addu Atoll. Males are considerably more plentiful than females.

Precis orithya ocyale H. (=*swinhoei* B.) : The Blue Pansy

One of the commonest butterflies in the Maldive Islands. 15 males and 14 females of the dry season form were taken in North Malé Atoll,

but only 2 males of the wet season form. In Addu, where it is, by far, the most attractive and plentiful of all the butterflies in that atoll, over 50 perfect insects were taken and many others were seen throughout the greater part of the year. They favoured the sandy, short-grass areas.

Precis hierta hierta F. : The Yellow Pansy

9 freshly emerged males and 8 females were taken in North Malé Atoll during January (1957) but the species was not met with in Addu. In North Malé Atoll it is evidently a resident and is moderately plentiful at times. It favours the same areas as the last species.

Family : Papilionidae

Only 2 species were taken in North Malé Atoll, a single specimen of one of them being also taken in Addu. A third species (probably **Papilio polytes**) was seen on the wing but evaded capture in North Malé. It seems very probable that all the individuals of this strong-flying family that appear in the Maldives have been blown over from the coasts of south India and Ceylon by the NE. Monsoon winds, vide the one seen during our voyage to Malé flying strongly some 200 miles to the east of the archipelago.

Atrophaneura (Polydorus) hector L. : The Crimson Rose

6 males were taken in North Malé Atoll and a single one in Addu ; no female was seen. This species appears to be an immigrant to the Maldives ; several were seen flying low and strongly over the waters of the lagoons and arriving from over the seas.

Atrophaneura (Polydorus) aristolochiae aristolochiae F. : The Common Rose

Rare. Probably an immigrant from south India. A single female was taken in North Malé Atoll ; the species was not observed in Addu.

Family : Pieridae

Represented by 5 species in North Malé Atoll but by only a single species in Addu. In addition to the 5 species taken in North Malé Atoll, a further species (probably **Hebomoia glaucippe** L.) was seen but it evaded capture.

Appias albina darada Fd.: The Common Albatross

Rare. A single male was taken in North Malé Atoll ; not observed in Addu Atoll.

Eurema brigitta rubella W. : The Small Grass Yellow

Scarce. 3 males and a female were taken in North Malé Atoll ; not met with in Addu.

Eurema hecabe simulata M. : The Common Grass Yellow

Widespread and plentiful throughout most of the year. While only 7 females were taken in North Malé Atoll, this species was common amongst the long grass on Gan Island, Addu Atoll. Many newly emerged specimens were taken.

Catopsilia pomona pomona F. : The Lemon Emigrant

Frequently met with amongst the bush-scrub on Hulule Island, close to Malé, in North Malé Atoll. 3 Males and 3 females were taken. Not met with in Addu Atoll.

Catopsilia pyranthe minna H. : The Mottled Emigrant

Plentiful in North Malé Atoll where 10 males and 53 females of the dry season form, and a single male and 4 females of the wet season form were taken. Females were far more numerous than males. Not met with in Addu Atoll.

Family : LYCAENIDAE

Well represented by 7 species in North Malé Atoll but by only 2 in Addu Atoll. Most species are very local in their distribution and tend to remain close to the plants on which their caterpillars feed.

Zizeeria knysna karsandra M. : The Dark Grass Blue

Moderately plentiful around the low, creeping *Lippia nodiflora* Rich. that covers the lawns and playing-fields, in the place of grass, in Malé, in North Malé Atoll. 8 males and 7 females were collected. Absent from Addu Atoll.

Zizina (Zizeeria) otis indica Mur. (=*devata* But.) : The Lesser Grass Blue

Abundant around the low, creeping *Lippia nodiflora* Rich. patches on Malé Island, in North Malé Atoll, but absent from Addu. Generally in association with the last species.

Zizula hylax F. (=*gaika* Tri.) : The Tiny Grass Blue

Moderately plentiful, in association with the last two species, around the low, creeping *Lippia nodiflora* Rich. areas in Malé, North Malé Atoll, but absent from Addu Atoll. 4 males and 8 females were taken.

Freyeria putli Koll. (=*Zizeeria trochilus putli* Koll.) : The Grass Jewel

A single male and 3 females were taken in North Malé Atoll. Appears to be an uncommon species. Not met with in Addu Atoll.

Lampides boeticus L.: The Pea Blue

A widespread and moderately plentiful species in North Malé Atoll. 2 specimens were taken, also, in Addu Atoll where it is much less common.

Euchrysops cnejus F. : The Gram Blue

Widespread and moderately common in North Malé Atoll and also in Addu Atoll where it is generally found in association with low, creeping plants of the pea family growing in matted patches on the sandy foreshore on Gan Island.

Spalgis epius Wd. : The Apefly

2 males and 7 females were taken around bushes in gardens and compounds in Malé, North Malé Atoll, where it appears to be resident in small numbers. Not met with in Addu Atoll.

Family: Hesperiidae

Only one species was taken in the Maldives but another species was seen on the wing (but evaded capture) in North Malé Atoll. The single species is widespread and plentiful.

Borbo cinnara Wall. (=*colaca* M.): Wallace's Swift or Skipper

Widespread and moderately plentiful. Although only 3 males were taken in North Malé Atoll, it was a common species amongst the grass and rank vegetation in Addu Atoll during the greater part of the year.

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Floral asymmetry in Malvaceae

BY

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(*With three text-figures*)

INTRODUCTION

The petals of a Malvaceous flower are twisted, either clockwise or anticlockwise. In the same plant of any species of this family, the two types of flowers occur almost in the same proportion (Davis 1964). Investigations show that this proportion is not affected significantly by seasonal variations. This peculiarity is conspicuously displayed also in Bombacaceae, a family formerly included under Malvaceae (Hooker 1872). Sterculiaceae, Cochlospermaceae, Linaceae, Caricaceae, Palmae, and less prominently Tiliaceae and a few others also show this floral asymmetry. The phyllotaxy of Malvaceae is alternate and the flowers are mostly solitary and axillary. (*Malachra capitata* is a good exception.) A critical study of the flowers on several shoots of a few species did not show that alternate leaves bear in their axils flowers of the same petal-twist. However, a 'variety' of *Althaea rosea* did not conform to this generalisation. The stamens of both the types of flowers were estimated in a few species, and no significant difference noticed between them.

OBSERVATION

When viewed apically, a flower is considered left-handed (clockwise aestivation) if the inner margin of a petal curves clockwisely towards the periphery, and right-handed if it curves counter-clockwisely. In figure 1 are seen the two types of flowers of a *Gossypium* species together with partial floral diagrams of the same. In most species

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[1] At the Madras Agricultural College & Research Institute, Coimbatore, 3

of this family, examination of even a single petal will help to determine the aestivation of the flower since the individual petals are asymmetrical. According to Rendle (1959), there is a positive correlation

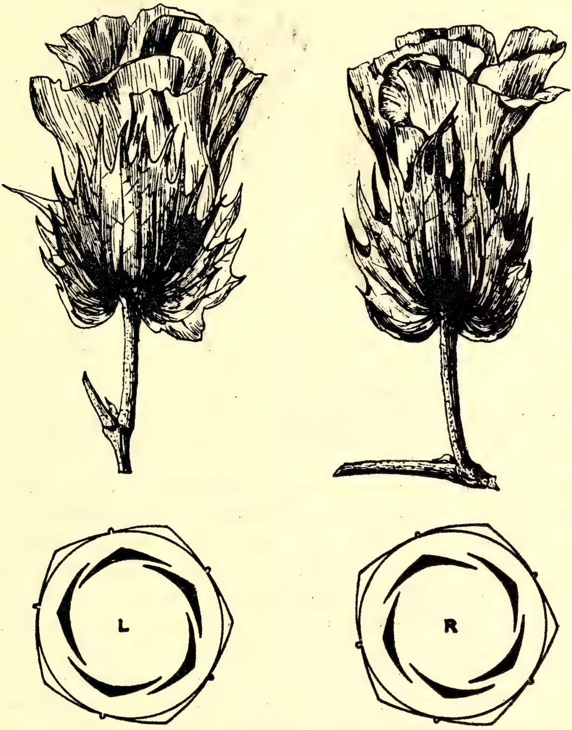

FIG. 1. Left- and right-handed flowers of *Gossypium barbadense*

between the asymmetric nature of a petal and twisted aestivation. In some species, such as *Hibiscus rosasinensis*, the monadelphous staminal tube twists clockwisely or conversely in accordance with the direction of twisting of the corolla (Fig. 2). In the case of *Thespesia populnea* it is possible to determine the nature of the petals by merely looking at the stigmata on account of their asymmetrical nature.

In Table I data on flowers of 34 species of Malvaceae are given. Most of these were personally collected by the senior author in and

around Calcutta, Bombay, and Colombo during 1961-1963, and for five species including portions of those for *Abutilon indicum* and

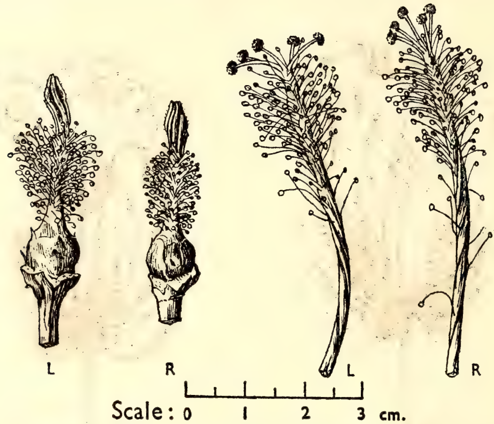

FIG. 2. The left two figures show stigmata (and stamens) of *Thespesia populnea* and the rest show staminal tubes in *Hibiscus rosasinensis*.

Hibiscus rosasinensis which show a significant excess for the left-handeds were collected from Coimbatore (south India) by the second author. Of the 34 species, 19 have excess left-handed flowers, and of these, the χ^2 values for only three species show a significant difference from equality. None of the 15 species having excess right-handeds, as is obvious from the table, shows a significant difference. The χ^2 value for the over-all population shows a significant difference from the expected even though the left-handeds form only 50.62 per cent. of the total flowers. This significance is brought about mainly by the figures for *Hibiscus rosasinensis* and *Abutilon indicum*. The figures received from Coimbatore for the latter showed a high percentage of left-handeds (67.1 per cent.). The data for *H. rosasinensis* relate to 46 bushes observed in Calcutta for a three-month period in 1961, 5 bushes for the year 1962, and 4 bushes from Coimbatore observed for two months in 1962. It may be mentioned that in all these populations the left-handed flowers were slightly in excess of the right-handeds, the mean on the total flowers being 51.25 ± 0.28 per cent. lefts. *H. rosasinensis* alone accounts for 43.27 per cent. of the total flowers studied, and the χ^2 value (20.6263) for this species largely affects the entire population, leading to a

significant excess for the lefts. Ignoring this species, equality may be expected for the rest of the species. Since the excess of lefts over

TABLE I

AESTIVATION IN FLOWERS OF SOME MALVACEOUS SPECIES

Species	No. of plants	Petal-twist		L+R	L — R	χ^2
		Left	Right			
1. *Abutilon hirtum*	12	1301	1371	2672	—70	1.8338
2. *Abutilon indicum*	9	315	222	537	93	16.1061
3. *Abutilon megapotamicum*	2	29	31	60	—2	0.0667
4. *Abutilon ochsenii* [1]	1	2	4	6	—2	0.6667
5. *Achania conzeitii*	2	168	156	324	12	0.4444
6. *Althaea rosea*	39	1445	1414	2859	31	0.3361
7. *Gossypium anomalum*	1	7	3	10	4	1.6000
8. *Gossypium arboreum*	5	683	649	1332	34	0.8679
9. *Gossypium barbadense*	26	663	627	1290	36	1.0047
10. *Gossypium davidsonii*	1	13	16	29	—3	0.3103
11. *Gossypium herbaceum*	3	8	6	14	2	0.2857
12. *Gossypium hirsutum*	14	397	391	788	6	0.0457
13. *Gossypium taitense*	3	8	6	14	2	0.2857
14. *Gossypium thurberi*	1	3	0	3	3	3.0000
15. *Gossypium* sp. (wild)	2	62	67	129	—5	0.1938
16. *Hibiscus cannabinus*	69	876	891	1767	—15	0.1273
17. *Hibiscus esculentus*	60	255	254	509	1	0.0020
18. *Hibiscus hirtus*	6	30	34	64	—4	0.2500
19. *Hibiscus indicus*	1	18	19	37	—1	0.0270
20. *Hibiscus mutabilis*	4	72	84	156	—12	0.9231
21. *Hibiscus rosasinensis*	55	16871	16047	32918	824	20.6263
22. *Hibiscus schizopetalus*	2	17	10	27	7	1.8148
23. *Hibiscus sabdariffa*	93	567	574	1141	—7	0.0429
24. *Hibiscus tiliaceus*	3	291	300	591	—9	0.1371
25. *Hibiscus tortuosus*	1	81	80	161	1	0,0062
26. *Hibiscus tricuspis*	1	14	13	27	1	0.0370
27. *Hoheria lyalli* [2]	1	3	6	9	—3	1.0000
28. *Malachra capitata*	6	8892	8883	17775	9	0.0046
29. *Malvastrum* sp.	2	27	32	59	—5	0.4237
30. *Pavonia coxi*	5	104	92	196	12	0.7347
31. *Pavonia odorata*	2	3	13	16	—10	6.2500
32. *Sida cordifolia*	23	3187	3049	6236	138	3.0539
33. *Thespesia populnea*	6	2282	2394	4676	—112	2.6826
34. *Urena lobata*	2	118	117	235	1	0.0043
Total ..	464	38812	37855	76667	957	65.1951

[1] From figure 149, *J. Roy. Hort. Soc.* **87**, 1962.
[2] From figure 1691, Text Book of Theoretical Botany **2**. R. C. Mclean & W. R. Ivimey Cook.

rights is persisting in the case of *H. rosasinensis* even with large samples, and during different seasons, this peculiarity requires to be investigated in detail.

In the graph, data on the left- and right-handed flowers of the 46 bushes of *H. rosasinensis* are expressed. Of these plants, 37 had excess lefts, one equality, and only 8 had excess of rights. The

probability of so great an excess is very small. The χ^2 test shows χ^2_1 (for totals)$=13.349$, $\chi^2_{46}=46.6031$, so $\chi^2_{45}=33.264$. There is not the faintest evidence of heterogeneity. That is, any plant would

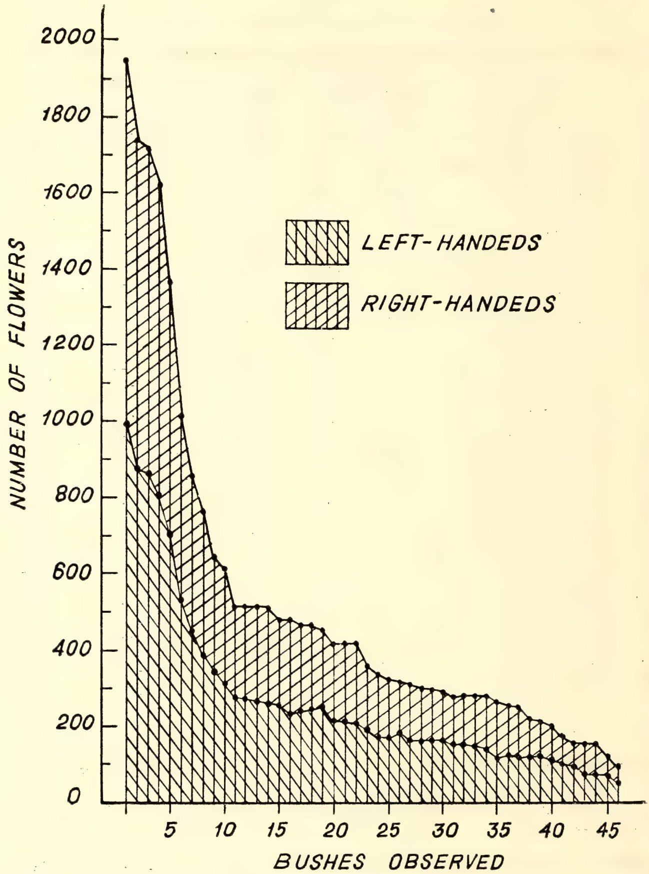

FIG. 3. Right- and left-handed flowers from 46 bushes of *Hibiscus rosasinensis* recorded for a three-month period in 1962

have differed from another if a bigger sample had been available. However, the situation is quite different from that of the groups of coconut palms (Davis 1962, 1963).

The leaves of Malvaceous plants are alternate and the flowers are mostly axillary. An examination of the flowers of consecutive leaf axils in some shoots of *Hibiscus cannabinus, H. sabdariffa, H. rosasinensis,* and *H. esculentus* did not show that alternate leaves bear in their axils flowers of the same petal-twist. The two types of flowers are randomly distributed on every shoot. Table II gives information on the flowers of thirteen branches (ranging from 4 to 13 per shoot) of *H. cannabinus.* Only one shoot out of thirteen shows a significant deviation from equality. During early 1962, a 'variety'

Table II

Flowers in consecutive leaf axils of 13 shoots of *Hibiscus cannabinus* (observed from 3rd to 15th November 1964)

Shoot	Flowers in leaf axils numbers													Total		$\frac{(L-R)^2}{L+R}$
	1	2	3	4	5	6	7	8	9	10	11	12	13			
1	R	R	R	R	L	R	R	R	R	L	R			2 L	9 R	4.4545
2	L	L	R	L	R	R	L	R	L	R				5 L	5 R	0
3	L	R	L	L	R									3 L	2 R	0.2000
4	R	L	R	R	L									2 L	3 R	0.2000
5	R	L	R	L	R	R	L	L	L	L	L	L	L	9 L	4 R	1.9231
6	L	R	L	L	R									3 L	2 R	0.2000
7	R	L	L	R	L	R								3 L	3 R	0
8	L	X	R	R	L	R	L							3 L	3 R	0
9	R	R	R	R	R									0 L	5 R	5.0000
10	L	R	R	R	L									2 L	3 R	0.1666
11	R	L	L	R										2 L	2 R	0
12	R	L	L	R	L	R								3 L	3 R	0
13	L	R	R	R	R	L								2 L	4 R	0.6667
	Total													39	48	12.8443

X= imbricate aestivation

of *Althaea rosea* grown at the Indian Statistical Institute's premises showed a peculiar pattern of arrangement of left- and right-handed flowers. Each leaf bore two flowers in most axils. The first flower was the normal axillary one and this was invariably a right-hander. Each axil produced an accessory flower always towards the right side of the axillary flower and this was invariably left-handed. Unfortunately this 'variety' could not be propagated again. Our observations during the subsequent seasons on other *Althaea rosea* plants gave the same story as the rest of the Malvaceae. Eichler (1878) seems to have observed in *Malva sylvestris* a regular pattern in the asymmetry, as adjacent flowers showed different direction of twisting.

At the request of the senior author, observations were made on the following Malvaceous species at the Stonehurst Estates, Ardingly, Sussex, by G. R. Wakefield: *Abutilon vitifolium, A. Sauvitzii, A. thompsonii, A. megapotamicum, Hibiscus syriacus, Hoheria lyalli, H. galabrata, Malva sylvestris*, and *M. rotundifolia*. The following is the summary of his observations reported in the *Nature* communication (Davis 1964) and reproduced here: 'Flowers on trusses of identical stages of growth do not appear to have the same opening pattern (twist); they do not seem to open alternately one way or the other. Flowers opening at different times of the year, consequently under different climatic conditions and light densities, do not show any regularity either one way or the other (right or left); likewise there seems to be no difference between flowers opening on the sunny side of the bush or the shaded side. Altogether I seem to be able to prove no pattern of regularity and the numbers seem to be roughly equal for either direction.'

The number of stamens of both right- and left-handed flowers of a few Malvaceous and several Bombacaceous species is being estimated on a large scale and the full account will be published elsewhere. In

TABLE III

Hibiscus rosasinensis: NUMBER OF STAMENS PER FLOWER

Lefts		Rights	
1	95	1	99
2	96	2	96
3	94	3	96
4	97	4	97
5	92	5	102
6	95	6	104
7	102	7	104
8	97	8	97
9	100	9	100
10	92	10	97
11	105	11	93
12	103	12	88
13	97	13	93
14	99	14	96
15	93	15	100
	1457		1462
Mean	97.13		97.47

Table III, data on the stamens of 15 flowers each of left- and right-handed flowers of *Hibiscus rosasinensis* are given. It is clear that both the types do not differ significantly.

Summary

The flowers of Malvaceae and Bombacaceae and most or a few species of Linaceae, Sterculiaceae, Cochlospermaceae, Caricaceae, Tiliaceae, and Palmae have contorted aestivation. In about half the number of flowers of any plant of any species of the above-mentioned families, the petals twist clockwise and the rest counter-clockwise. This proportion of lefts and rights is maintained throughout the flowering season. The number of stamens of a right-handed flower does not differ significantly from that of a left-handed one of the same species.

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Four new races of birds from the Andaman and Nicobar Islands

BY

HUMAYUN ABDULALI

(*With one plate*)

INTRODUCTION

In February 1964, I spent about three weeks collecting birds in South and Middle Andamans, followed by a short trip to Car Nicobar; during this period I obtained 312 specimens of some 110 species and subspecies. As no work has been done on the Andaman and Nicobar birds within recent years, I propose to try to get together all that has been recorded about them. In the absence of some of the relevant literature in Bombay, together with the necessity of consulting individuals and institutions abroad for the identification of such forms as are not available in the collections of the Bombay Natural History Society, this will take some time. In this preliminary note I am describing four new races, and hope it will be possible to complete my inquiries and dispose of several additional possibilities in the note under preparation.

Tytler, Davison, Hume, Butler, and others made large collections in the Andamans and Nicobars almost a hundred years ago. These were studied in the latter half of the last century when the relatively small differences on which subspecies are recognized were not accepted; though these differences were sometimes mentioned, the nomenclature was left unchanged. When subspecies were accepted in Indian ornithology, many of the island species were demoted to trinomial level. No ornithological field work has been done in that area for the last fifty years and there is no evidence to show how carefully the old collections were re-examined when revising the avifauna. These collections are not available to us and the British Museum (Natural History) tell me that, owing to pressure of work in other directions, it is not possible for them to re-examine their collections to check upon the correctness of some of my conclusions. The Zoological Survey of India have within recent years sent three expeditions to the Andamans,

and some birds were obtained. I am, however, informed that as their collections 'are being actively worked out' they are unable to send me a list of the material collected, to enable me to seek consultation where necessary. Under the circumstances, I have to rely on the evidence of the small series which I obtained but, considering that two of my findings are supported by the statements made by earlier workers with large series before them, I do not think that my conclusions are unjustified and that I shall be accused of littering the ornithological highway.

1. Amaurornis phoenicurus

Hume (1874, *Stray Feathers* **2** : 300) referred to several specimens of *Amaurornis phoenicurus* from the Andamans and Nicobars differing from those from India (Plate, fig. 1) in:

(*a*) the width of the white frontal band, exceeding .45 inch (11.4 mm.) and even an inch (25 mm.),

(*b*) much less white on the undersurface, the stripe ceasing on the upper abdomen in Nicobar birds, and

(*c*) the lower belly, vent, and tibial plumes being chestnut, and only slightly paler than the lower tail coverts, as against white or faintly tinged rufescent in Indian birds.

He stressed the fact that these differences are only apparent in adult birds.

Sharpe (1894, CAT. BDS. BRIT. MUS. **23** : 162) described *insularis* from the Andamans and Nicobars as similar to *phoenicurus*, but everywhere much darker dingy olive above, the sides of the breast blackish with only a slight wash of dull olive and scarcely any appearance of slaty grey, and the white of the forehead and eyebrow much more extended than in true *phoenicurus*. This was on an examination of 13 specimens from both the groups of islands.

Blanford (1898, FAUNA **4** : 174) referred to the extensive white on the head and the narrow stripe down the breast. He agreed that *insularis* was a well-marked race, but stated that some of the peculiarities were sometimes found in the mainland specimens. Stuart Baker (1928, FAUNA **6** : 25) accepted the race *insularis* but restricted it to the Andamans, not saying what form was found in the Nicobars. He described it as the darkest of all the Indian forms, with more extensive white on the forehead, and the breast blackish grey with very little olive tint. Ripley in the SYNOPSIS placed *insularis* in both the Andamans and Nicobars.

I have only one specimen each from South Andaman and Car Nicobar.

From the literature and material available to me, I cannot help feeling that this apparent confusion is due to the failure of Hume, Sharpe, and Stuart Baker to examine the birds from the Andamans and Nicobars separately.

The Andaman bird (Plate, fig. 2) has the white of the breast restricted to a small area on the upper breast, which is joined to the white of the underbelly by a narrow strip in the centre. The olive-green wash above and below is less pronounced, and the undertail coverts and tibial plumes are more brown and less chestnut than in Indian birds, which it resembles in other respects.

The Car Nicobar bird (Plate, fig. 3) has the whole head and nape almost all-white except for irregular spots of grey on the crown and nape. There is no olive-green on either the upper or lower parts, and though there is more white on the breast than in the Andaman bird, the middle stripe is narrower and does not appear, from the skin as prepared, to connect unbroken with the white of the underbelly. The undertail coverts and tibial plumes are as in the Andaman bird.

Young birds in India, *phoenicurus*, show almost no white on the forehead, and it is probable that the Nicobar birds pass through a stage when the white on the head is not so extensive.

Butler (1900, Birds of the Andaman & Nicobar Islands, *J. Bombay nat. Hist. Soc.* **13** : 144) handled over 150 specimens in the Andamans (in traps set for *Rallus canningi*) and stated that he had never found one with the extensive white on the head seen in Nicobar birds. P. B. Shekar, Field Assistant of the Bombay Natural History Society, who was with me on this trip and who collected this specimen in Car Nicobar, remembers seeing others in which the white head was noticeable.

In view of the above, I think I am justified in restricting *insularis* to the Andamans, and I separate the birds from Car Nicobar as:

Amaurornis phoenicurus leucocephalus subsp. nov.

Holotype: ♀ collected by P. B. Shekar on Car Nicobar on 14 March 1964, and in the Bombay Natural History Society's collection bearing Register No. 21547. The wing measures 163 mm.

2. Ducula aenea

Hume (1874, *Stray Feathers* **2** : 261) drew attention to the birds from the Andamans being in series larger, greener, with deeper-coloured undertail coverts, and having whiter foreheads and throats

E. Reuben del.

Amaurornis phoenicurus (Diagrammatic)

1. *A. p. phoenicurus* (India); 2. *A. p. insularis* (Andamans); 3. *A. p. leucocephalus* ssp. nov. (Car Nicobars)

than a series from any place in India, Burma, or Ceylon. He also noted that none of his 25 specimens from the Andamans had such a brilliantly red copper gloss as some continental examples exhibited. Stuart Baker (FAUNA **5** : 208) also noticed the greater prominence of white on the forehead but in a footnote on the previous page referred to Hartert (*Nov. Zool.* **25** : 346; 1918) *showing* that the Andaman bird is not separable from the Indian *sylvatica*. Hartert (loc. cit.) only says of *sylvatica*: 'This form seems to extend to the Andaman Islands.' Peters (1937, CHECK-LIST OF BIRDS OF THE WORLD **3**) in a footnote to *sylvatica* at p. 46 states: 'The Andaman birds possibly represent a distinct race.'

An examination of the present series (5 ♂♂, 4 ♀♀) together with the other material and literature in Bombay leads to the following findings:

The white of the forehead and the chin (except in one female) is strikingly more pronounced than in any from south, central, or north-eastern India. The green feathers of the upper surface show almost no copper gloss and many on the back and on the wing coverts are broadly tipped with dark blue (almost black). The tail shows less green and is not concolorous with the back as in the others. While some of these differences may to some extent be seasonal, sexual, and/or due to the age of the individuals, they are sufficiently constant to permit the birds being picked out from among the others.

Their measurements (in mm.) are compared below with those of others in the Bombay collection:

	♂♂	Wings		♀♀	Wings	
Andamans	13* ..	222-257	av. 236	8 ..	212-240	av. 227
Salem, Madras	1 ..	212	212			
Orissa	3 ..	219-235	226.6			
Bastar, M.P.	1 ..	224	224	2 ..	218-219	218.5
Chanda, Maharashtra	2 ..	220-230	225			
Assam	1 ..	235	235			
Burma	2 ..	231-245	238			
Kanara, Mysore	2 ..	222-226	224			

	♂♂	Tails		♀♀	Tails	
Andamans	5 ..	155-161	av. 157.6	4 ..	137-146	av. 142.25
Salem, Madras	1 ..	129	129			
Orissa	3 ..	137-150	143			
Bastar, M.P.	1 ..	143	143	2 ..	135-140	137.5
Chanda, Maharashtra	2 ..	126-147	136.5			
Assam	1 ..	142	142			
Burma	2 ..	129-144	136.5			
Kanara, Mysore	2 ..	133-154	143.5			

* Includes birds shot for the pot, whose tails were not measured.

Apart from the larger size of the wing, the tails of the Andaman males are distinctly longer than in any others from India. They differ from typical *aenea* from Malaya in the absence of the pinkish tinge on the cheeks, ear coverts, and throat (which are grey as in *sylvatica* from India). The Nicobar race, *nicobarica* Pelzeln, is a distinctly larger bird, with the undertail coverts dingy brown and not bright chestnut as in the other races. I therefore separate the Andaman birds as:

Ducula aenea andamanica subsp. nov.[1]

Holotype: ♂ collected by me at Betapur, Middle Andamans, on 23 February 1964 and in the Bombay Natural History Society's collection bearing Register No. 21546.

Paratypes: 3 ♂♂ Nos. 21548, 21549, 21553, 2 ♀♀ Nos. 21550, 21552 in Society's collection, 1 ♂ in University Zoological Museum, Berlin, 1 ♀ in Prince of Wales Museum, Bombay, and 1 ♀ in National Museum, Singapore.

Stuart Baker (FAUNA **5** : 207) refers to the bill of the typical form being white at the tip. In the Andaman birds this was not so in life, but became noticeably white within a couple of months.

3. PELARGOPSIS CAPENSIS

The Andaman birds are included with *burmanica* Sharpe (Taunghoo, Burma) in both Stuart Baker's FAUNA and Ripley's SYNOPSIS. Stuart Baker notes that birds from the Andamans are very pale and worn and rather small in size but with larger bills. Earlier, in Hand-list of Birds of the Indian Empire (*J. Bombay nat. Hist. Soc.* **28** : 316), he referred to '*Ramphalcyon capensis osmastoni* Stuart Baker, described from the Andamans in *Bull. B. O. C.* . . .' but gave no details. I have not been able to find this either in *Bull. B. O. C.* or in Stuart Baker's volume of synonyms appended to the FAUNA. So it would appear that the description was never published and the name remains a *nomen nudum* (as already noted by Laubmann, vide *Ibis*, 1931, p. 314).

Two females collected at Chiria Tapoo, South Andaman, and Long Island, Middle Andamans, have their wings 147-156 mm. (146-165 for *burmanica* in FAUNA) and bills 80, 80 mm. (72-84). These measurements overlap, but the heads of the Andaman birds are much paler than those of specimens of *burmanica* from Prome (♀, 17th January) and Lower Chindwin (♂, 28th January). The dark brown

[1] After this went to the press, Dr. B. Biswas, Zoological Survey of India, informed me that he agreed with my finding.

head of *capensis* (India) and the lighter head of *burmanica* are all uniformly coloured, while in the Andaman birds, the greyish feathers of the head have broad pale tips and margins giving a broken effect which Hume referred to as whitey-brown. Ball [*Jour. Asiatic Soc. Bengal*, 1872, **4** (2) : 277] also refers to Andaman birds as differing from *burmanica* in the more albescent head. The collar in my specimens is very distinct. The upper wing coverts have very little of the blue so prominent in *capensis*, and are almost all grey as in *burmanica*. The intensity of the chestnut on the underpart appears to be a variable character in this species. The Nicobar race *intermedia* Hume is separable by the crown being ochraceous and concolorous with the collar.

On these differences I separate the Andaman birds and, in recognition of the hard work in the field and in the preparation of skins done by P. B. Shekar, I name them as:

Pelargopsis capensis shekarii subsp. nov.

Holotype: ♀ collected by me at Chiria Tapoo, South Andaman, on 15 February 1964, and in the Bombay Natural History Society's collection bearing Register No. 21544.

Paratype: ♀ in the Society's collection bearing No. 21545.

4. Irena puella

For many years only one form of this widely distributed Indo-Malayan species was recognized from Indian limits, of which the type locality ' India ' was restricted to Travancore by Stuart Baker. The Malayan birds were separated as *malayensis* by Horsfield & Moore by their tail coverts being longer, almost reaching the tip of the tail.

Whistler & Kinnear (*J. Bombay nat. Hist. Soc.* **36** : 582) drew attention to north Indian birds being larger than those from south India :

Wings of 12 adult males from the south : 123-131 mm.,

Wings of 10 adult males from Sikkim and the Duars : 133.5-141 mm., and separated the former as *sikkimensis*, type locality Sukna, Darjeeling District. Ripley in the SYNOPSIS has listed the Andaman and Nicobar birds as of this race. Though Blanford (old FAUNA) also referred to the occurrence of this species in the Nicobars, I can find no original record, except for Butler's (*J. Bombay nat. Hist. Soc.* **12** : 390) statement that it is found in both groups. If it occurs in the Nicobars, the race remains to be determined.

The six specimens collected (3 adult males, 2 immature males, and 1 female) do not differ from Indian birds in colour or length of tail

MEASUREMENTS OF *Irena puella*

No. of specimens		Wing mm.	Tail mm.	Length of bill from gape mm.	Depth of bill mm.
Adult ♂♂					
sikkimensis	8	123-138, av. 132.6	99-112, av. 102.6	28-30, av. 28.4	9-12, av. 9.9
do. (excluding shortest which appears exceptional)	7	132-138, av. 134	—	—	—
puella	8	126-131, av. 128	99-107, av. 104	25-30, av. 27.75	10-11, av. 10.5
Andamans	3	129-133, av. 130.6	106-110, av. 108.6	31-33, av. 32	11, av. 11
Immature ♂♂					
sikkimensis	4	120-133, av. 129	100-107, av. 102	27-29, av. 27.5	9-10, av. 9.25
puella	nil	—	—	—	—
Andamans	2	123, 128, av. 125.5	102, 102, av. 102	31, 31, av. 31	11, 12, av. 11.25
Females					
sikkimensis	6	124-130, av. 127	92-112, av. 100	29-32, av. 30	10-11, av. 10.5
puella	9	119-128, av. 124.2	95-108, av. 103.6	28-30, av. 29	9-11, av. 10
Andamans	1	131	108	32, av. 32	12, av. 12

coverts, but some of the other measurements (see table at p. 416) are significant.

In wing-size the adult males from the Andamans appear to be nearer *puella* while their tails (106-110, av. 108.6) average longer than in both *puella* and *sikkimensis*.

In addition, the Andaman birds have distinctly longer and heavier bills, though the latter characteristic is not indicated by the measurements to the extent that it is visible to the eye.

The smaller wing removes them from *sikkimensis* while the longer tail and bill separate them from typical *puella* in the south-west. These differences were referred to Dr. B. Biswas of the Zoological Survey of India, and he writes that they are confirmed by comparison with the specimens available to him. I therefore name the Andaman birds :

Irena puella andamanica subsp. nov.

Holotype : ♂ collected by me at Long Island, Middle Andamans, on 27 February 1964, and in the Bombay Natural History Society's collection bearing Register No. 21747.

Paratypes : 2 ad. ♂♂ Nos. 21748 and 21752 ; 2 imm. ♂♂ Nos. 21749 and 21751 ; 1 ad. ♀ No. 21750.

I might mention that Hume (1874, *Stray Feathers* **2** : 226) thought the Andaman birds identical with those from south India and Sikkim, but referred to a young male from the Andamans, which had many green feathers intermingled with the black of the chin, throat and breast, 'while the feathers of the head, back, and rump, are green, only narrowly tipped with shining blue.'

In Memoriam

LOKE WAN THO

(*With a plate*)

The death on 20 June 1964 of Loke Wan Tho is a grievous loss to the Society, to his innumerable friends throughout the world, and to the cause of ornithology of the Oriental Region. He was killed in an air crash in Taiwan while returning to Taipei from a visit to the museum at Taichung—a paltry half-hour's flight. It was typical of Loke's passion for the rare and the beautiful that he could never resist even a fleeting opportunity to look at a good art gallery, or a collection of old porcelain, or books, or birds, or a spell of bird watching and photography. On this fateful day he had a few hours to spare from official engagements, so while the other members of his delegation to the International Film Festival slept off the exhaustion of a hectic week in preparation for the grand finale that evening, Loke thought to employ his leisure to better purpose—with this tragic result.

Wan Tho was born at Kuala Lumpur on 14 June 1915. He was sent to an English school (Chillon College) in Switzerland at an early age because of his delicate health, passing thence to Cambridge (King's College) where he took his M.A. in English Literature and History in 1936. Thereafter he attended the London School of Economics for two years before returning to Malaya. English literature and poetry were among his great loves, and among his severely pruned personal kit on expeditions were always to be found a couple of favourite anthologies which were the first things to be unpacked as soon as camp was established.

Loke's connection with the Bombay Natural History Society dates from 1942, not long after he landed here as an evacuee from Singapore in the wake of the Japanese occupation. During the adventurous voyage out his ship was bombed by Japanese aircraft, he himself being rescued from the sea, temporarily blinded and half killed. Being in the fortunate position of not having to seek an immediate livelihood, a happy coincidence launched him into the serious study of birds to which he already possessed a strong natural leaning. It was during this period that some of the regional bird surveys by myself under the sponsorship of the Society were under way. No great persuasion

Loke Wan Tho

was needed for Loke to attach himself to one of these. He soon proved an exceptionally enthusiastic observer and collector of birds, and later also a capable assistant in the taxonomical studies on the collections, acquiring in the process a sounder all-round knowledge of Indian ornithology than is possessed by many a more seasoned amateur. His unfailing courtesy and quiet good manners, friendly disposition, and capacity to mix at all levels and to remain cheerful and unruffled under a leader not reputed for sweetness of temper were other qualities that made him a welcome adjunct to the field camps. Never grumbling or complaining, ever ready to share all physical hardships and deprivations, even with a show of enjoyment, he was an ideal companion. Any one with experience of this type of rough-and-ready camping in India—often living for days in bug-infested dharamsalas or dilapidated drafty cattlesheds under the light of smoky hurricane lanterns at night—with one eye constantly glued on the budget, as was doubly necessary in the war years—will admit that this is the supreme test of a congenial camp companion. And through it all he never lost his capacity to look on the humorous side of uninspiring situations.

One of the wealthiest men in Malaysia, Loke was a rich man with a difference, especially as millionaires in our part of the world go. All his tastes were essentially simple, cultured, and humanistic, and his love of Nature an enduring passion. Since his return to Malaya at the end of the war, in 1945, he became increasingly caught up in business affairs. Responsible honorary public offices were thrust on him one after another by an appreciative public and Government. The tact, conscientiousness, and complete integrity and efficiency with which he discharged his functions won him the respect and admiration of all. All this in addition to the cares of the vast business empire he had built up around himself left people amazed at how he ever managed to find the time to keep so closely in touch with his intellectual pursuits. It was also a wonder to his more intimate associates how he kept himself so well informed about details of the various enterprises with which he was connected—for instance the comparative merits of different types of aircraft, the latest automobile engines and their relative performances, the superiority of Swedish telephone systems and equipment over those of other countries, and things of that sort.

In later years he sometimes said with a touch of sadness that though he was fortunate enough to possess the means for carefree indulgence in the things nearest to his heart—outdoor life, expeditions, camping, mountaineering, studying and photographing birds—he found

himself left with less and less leisure to take advantage of the facilities. Therefore, he had to take his pleasure in these things vicariously by helping scientific expeditions and other deserving causes with funds and in other ways. His generosity and munificence were as liberal as they were unostentatious and genuine, and his patronage extended in multifarious directions—helping promising youngsters to higher education and technical training abroad, sponsoring the visit of a badminton team to a foreign country, or promoting the building up of a school or library.

Loke was a great lover of English literature with a fine sense of appreciation and criticism. This made him a charming and stimulating companion in camp when, after dinner, all the mundane chores were over and we sat reading with the help of a couple of miserable hurricane lanterns. He would break out into reading aloud to his companions passages which especially caught his fancy, sometimes with a chuckle and often an obvious smacking of the lips. He himself wrote pleasingly with an easy style and a keen sense of humour, and his contributions to journals and magazines were eagerly sought after. His articles from time to time in the journal of the Bombay Natural History Society, illustrated with his own excellent photographs were always enjoyed and greatly looked forward to. He became an EHA-fan while in India and wrote a beautiful little biographical sketch of EHA to preface a new edition of the classic COMMON BIRDS OF BOMBAY published by Thackers in 1943 under the altered title COMMON BIRDS OF INDIA. Loke kept a detailed diary of day-to-day activities and happenings in camp which he wrote up meticulously every night before going to bed, and thus amassed a good deal of material for future literary efforts. The only book he published was entitled—after a favourite passage from EHA—A COMPANY OF BIRDS. It quickly ran to two impressions and drew an appreciative press. It is chiefly an album of some of his outstanding bird photographs with a useful introduction to the techniques he so successfully employed and some very readable reminiscences as a bird photographer. In photography as in everything else he chose to take up, whether for business or pleasure, Loke was a perfectionist. While seeming to airily click his camera he would have carefully calculated in advance the result he was likely to attain by underexposing by so much and later by overdeveloping the negative by so much, minutiae that accounted for the disparaging difference his companions usually found between exposures made by themselves—of the same subject, at the same time, and from the same spot—and the results *he* produced! It was therefore by no accident that he came to be

regarded as one of the finest photographers in the East, not only of birds but also of archaeological subjects. His photographs illustrating Malcolm Macdonald's book on Angkor testify to this verdict. The ease and willing readiness with which he made his photographs available to all and sundry magazines and scientific publications that sought his co-operation brought his work to the notice of a wide international circle of discriminating ornithologists and photographers and served to enhance his fame. He received many coveted awards at numerous international photographic exhibitions.

At the time of his death Loke was, among other things, Pro-Chancellor of the University of Malaya, a member of the Court of the University of Singapore, Chairman of the National Library Board, Singapore, and Member of Council of Singapore Institute of Management and Economic Development, and held similar honorary offices in numerous other public and quasi-governmental bodies. He was Chairman of Malayan Air Lines, and served as Chairman of the Singapore Telephone Board during its formative phase between 1953 and 1959. Besides these he was President, Vice-President, or Council Member of innumerable societies connected with social service, sport, natural history, photography, music, and other cultural pursuits, a Vice-Patron of the Bombay Natural History Society, representative of Malaya on the International Council for Bird Preservation, and Chairman of the Malaysian National Section of the same. He was the recipient of high honours and decorations from the State of Kelantan and the Federation of Malaya for his public services and benefactions, and also personally from Prince Sihanouk of Cambodia and the Emperor of Japan. In addition there was, of course, his own gigantic Cathay Organization with its chain of 60 cinemas throughout Malaysia, and film production studios and hotels in Hong Kong, Fiji, and Singapore. He was director or chairman of numerous companies concerned with rubber, tin, and real estate in Singapore and Malaya, and with banking, shipping, insurance, automobiles, and other business.

Apart from a genuine well-wisher and active life member, the Society has lost in him a continuing benefactor who has helped financially and by personal participation in many of its scientific field projects and publications, and in other ways.

Loke was married last September in London. His wife was also killed with him in the crash. He leaves behind his mother, two sisters, and a step-daughter (by his wife's former husband). To them the Society extends its sincerest condolence.

SÁLIM ALI

Reviews

1. A STUDY IN BEHAVIOUR. By S. A. Barnett. pp. xvi+ 288 (22×14.5 cm.). With 14 black-and-white plates and 74 text-figures. London, 1963. Methuen & Co. Ltd. Price 45*s*. net in U.K. only.

Dr. Barnett, Senior Lecturer in Zoology at the University of Glasgow, has written a readable study of the behaviour of the rat, in which some of the major experimental and analytical problems of Animal Behaviour are adequately reviewed. The work is perhaps best considered a textbook eminently suited to first or second year classes in honours courses in those Universities providing some formal teaching in behaviour. The balanced approach of the author makes his book equally suited to either the Zoology or the Psychology Department.

The main title of the book is reminiscent of a not too distant era in which competing students of learning presented experimental data on the White Rat to promote theories purporting to explain all behavioural phenomena. In fact Dr. Barnett has no such axe to grind. As a zoologist it is natural that his approach should incline to the physiological 'molecular' analysis of factors causing behaviour rather than the more 'molar' approach. In this he reflects the present climate of opinion in which 'mechanisms' of behaviour are of greater interest than general statements about behavioural 'laws'. Considerable weight is given to the descriptive study of the animals in a natural or semi-natural setting, a field in which the author himself has made notable contributions. He treats his subject from the viewpoints of ethology, physiology, and experimental psychology; an attempt at a synthesis which, given the relatively small compass of the book, has considerable success.

To begin with, the author stresses the importance of adequate definition and precision of statement in the behavioural sciences—a stress particularly needed as some ethologists have in the past been distinctly unsophisticated in their handling of concepts. In two appendices the semantics of definition and a glossary of terms are provided. This emphasis on clarity pervades the whole book, although this reviewer felt it occasionally almost pedantic to an extent that

actually obscured. Thus on p. 178 in discussing stimuli in the context of Mowrer's learning theory it is pointed out that these include internal processes 'even some which go on in the brain'—a point that hardly needed labouring. Again, on p. 194 the term 'substitutive behaviour' is used for a phenomenon traditionally called 'displacement activity'. While it is now realized that 'displacement' in the sense of the transfer of action-specific energy emerging from one 'channel' to another in the central nervous system is an inadequate explanatory concept, the idea of substitution seems equally unhelpful. In fact a term often used is simply 'out of context behaviour', a descriptive name which moreover fits very well into the context of contemporary causal explanation in terms of 'disinhibition'. Nor is it likely that the notes in the glossary will gain acceptance from everybody, although the author carefully says that the definitions given are designed simply to state how the terms are used in this particular book. For example, some comparative psychologists might cavil at ethology being described as 'the scientific study of animal behaviour'. While modern experimental ethologists may use the term in this way with some justification, ethology was for a long time concerned specifically with the narrower study of expression movements and gesture. It is perhaps still useful to apply the term to a particular approach to behavioural problems—distinct for example from that of many strict 'behaviourists', rather than to promote it pontifically to an all-inclusive status.

The main body of the work treats in considerable detail studies of: (i) appetitive and exploratory behaviour, range and territory and their relation to ecology; (ii) the natural history of feeding behaviour and the internal mechanisms responsible for it; (iii) the social behaviour of the rat; (iv) innate behaviour patterns, in particular those of reproductive behaviour, and genetics; (v) the types of learning encountered in the rat and their experimental and theoretical analysis; (vi) problems of motivation and its physiological causation; (vii) the brain and behaviour.

The book thus belongs to no 'school'. Dr. Barnett has written an unbiased review of a highly complex field that will form an excellent introduction to behaviour study for anyone not afraid of difficult contemporary problems.

J.H.C.

2. THE WILD LIFE OF INDIA. By E. P. Gee, with a Foreword by Jawaharlal Nehru. pp. 192 (15×22 cm.). 12 coloured and 20 monochrome plates from photographs. London, 1964. Collins. Price 30*s*. net.

Since the coming of our Independence few persons in the country have shown so much missionary zeal and dedication in the cause of wild life preservation as E. P. Gee. After his retirement from tea planting in Assam Mr. Gee, a Britisher, has chosen to make his home in Shillong and has devoted himself particularly to the study and photography of wild animals. Starting literally from scratch—from no interest at all in the local fauna and flora during his early years in the country, except perhaps for some little shooting in the normal planter tradition—he has developed into a keen and knowledgeable naturalist, and a champion of India's wild life second only to the late redoubtable Col. R. W. Burton. The rhinos of Kaziranga have reason to be grateful to Mr. Gee for his ceaseless campaigning in their behalf. It was fortunate for them that there happened to be at the head of the Assam Forest Department at the right time an equally enthusiastic conservationist in the person of P. D. Stracey. These two men between them did more to save the rhino in Assam than any one else, and by this they have earned the gratitude of posterity both human and rhinoceran.

THE WILD LIFE OF INDIA is written chiefly with the object of creating an interest in the public and arousing its conscience for the preservation of a precious national heritage which is fast going by default because of insufficient public appreciation and official apathy. It is an attempt to acquaint the public, and particularly the rising generation, with the appearance and habits of the unique fauna we possess, and thereby to mobilize enlightened public opinion to back the struggles of the handful of private individuals and scientific societies in the cause of its preservation. Without the backing of a well-informed, and therefore sympathetic, public opinion no measure however well-intentioned can prove effective. And at no time was the necessity for this support more crucial or urgent than it is today. The explosive natural (or unnatural!) outburst of our population, plus the influx of countless refugees from across our borders, the cutting down of forests to grow more food for these hungry hordes, and the vast projects of industrialization in order partly to provide them with jobs and raise the general standard of living, are gathering momentum with each passing day. These precisely are some of the factors that militate directly against the survival of wild life unless adequate,

well-considered, long-term safeguards are provided for it now and without delay.

Mr. Gee's effort to reach the responsive chord in his readers is made easier by the excellent photographs he offers them of the more spectacular forms of wild life found in the country. Most of these photographs have been taken by himself in the various National Parks and Wild Life Sanctuaries. Over the years Gee has blossomed into a wild life photographer of exceptional merit, and some of the pictures reproduced in the book are truly superb. It is a pity that the few of them obviously of animals in captivity, e.g. tiger (Plate 22b and coloured 5a), are not clearly marked as such. Those who know a wild tiger may be somewhat intrigued by the loose fold of skin hanging under the belly of the one in colour!

The text is largely an account of the author's experiences while in pursuit of the animals with his camera, and should be of much profit to those aspiring to follow in his footsteps. He furnishes helpful hints about the best seasons and conditions for wild life photography in India, suggestions which should also prove invaluable, particularly for those foreign tourists who may be planning in advance to visit our sanctuaries.

In the case of several of the larger animals Mr. Gee offers his estimates of the present-day population as compared with that of fifty years ago. For example he estimates the total number of elephants in the whole of India today to be about 7000; of tiger about 4000 contrasted with 'a possible 40,000 of fifty years ago'; of leopards 6000-7000 'as compared with 10 times that number fifty years ago'; of wild asses 860; Great Indian Rhinoceros 625. Of the Kashmir Stag he estimates 175-200 in 1962, against 400 in 1957, about 2000 in 1947, and 'probably about 5000 fifty years ago'. Whatever the accuracy of these figures, the decline within recent years has certainly been cataclysmic and alarming. As no proper censuses have been taken and the author's present-day estimates must largely rest upon his own limited observations plus not too reliable local testimony, they must of course be taken with reserve and as purely subjective, as they are clearly meant to be. He may be right in feeling that *some* estimate based on reasonable premises is better than no estimate at all; but the reviewer cannot help admiring his courage in estimating the 'probable' populations of 50 years ago for which even fewer and less reliable data are available. It is nevertheless the firm belief of the reviewer—and doubtless of others with experience of conservation too—that unless we have fairly dependable censuses, any measures for the preservation of a species are bound to prove shots in the dark.

Unless tolerably accurate periodical censuses can demonstrate that the species has benefited or suffered numerically after the adoption of a measure, e.g. total closure of hunting, it is impossible to make an objective assessment of a situation. Population figures based on haphazard visual estimation over short periods—by rote, as it were—can at best be an entertaining exercise but not one on which any control measures of a more or less drastic nature can be safely undertaken. It is precisely for this reason that there has been a constant demand from a knowledgeable section of the Indian Board for Wild Life (including the author) for an experienced and competent expert of the International Union for Conservation of Nature to be invited to India to do some pioneering in wild life census work here, and also to train local workers in the adaptation of approved scientific techniques to local conditions. As a test case it would be interesting, for instance, to see how closely or otherwise the expert's estimate for lions in the Gir forest tallies with the results obtained by our own methods.

The book is attractively got up and a joy to handle. The plates, both coloured and monochrome, are beautifully reproduced, and every one connected with the publication deserves high praise.

S.A.

3. ELEPHANT GOLD. By P. D. Stracey. pp. 227 (22 × 15 cm.). With 27 black-and-white plates. London, 1963. Weidenfeld & Nicolson. Price 30*s*. net.

The author, who recently retired from the Indian Forest Service (but is again Chief Conservator of Forests in Nagaland) was in elephant country during most of his service and, having both caught and shot elephants, is particularly well qualified to write about them. In the course of the chapters on A Stockade Officer's Life, Pioneer Elephant Catchers, Elephant Drives (Kheddas), Handling and Training, Myth and History, Rogues and Killers and other aspects, he has gone over much of what is known about these large and interesting animals. Looked at from the natural history point of view, however, one is distressed to see how little is known about them.

Like most other animals, elephants have dwindled rapidly in numbers and we do not know how long they will survive. The author refers to one man in Wynaad killing 300 and a reward being paid for the destruction of 5194 elephants in a part of Ceylon between 1845 and 1869! One wonders if numbers on this scale still exist.

The 27 black-and-white illustrations are excellent but are all of elephants—they include an extraordinary photograph of an elephant poised on its trunk and forelegs and displaying the 'monstrous beauty of its hind quarters' high up in the air. We are told by the author that the gestation period is twenty months for a female calf and twenty-two months for a male.

H.A.

4. THE WATERFOWL OF THE WORLD. By Jean Delacour. Volume IV. pp. 364 (24.50 × 18.50 cm.). With contributions by several specialists, 6 plates in colour by Peter Scott, and numerous monochrome illustrations and distribution maps. London, 1964. Country Life Ltd. Price £6-6-0.

This is the final part of a remarkable book by two remarkable ornithologists. The first three volumes, two of them reviewed in previous issues of the *Journal*[1], described and illustrated every species and subspecies of the Swans, Geese, and Ducks found throughout the world. This fourth volume rounds off the series with an over-all survey of the order Anseriformes, and covers such general topics as are usually found in the introductory portions of a book. The authors were wise in their decision to reverse this convention because during the ten years since the publication of the first volume—and partly due to the fillip to intensive waterfowl research given by it and its successors—a great deal of fresh data has become available. The deferment has thus enabled the results to be embodied here, making the information fuller and more up-to-date than it would otherwise have been.

A number of well-known specialists have contributed to the various aspects of anserine biology: Milton W. Weller is responsible for the sections on General Habits, the Reproductive Cycle, Ecology, Fowling, Distribution and Species Relationships, and Conservation and Management; Jean Delacour himself has written on Aviculture, and Domestic Waterfowl; Philip S. Humphrey and George A. Clark, Jr., on the Anatomy of Waterfowl; and Hildegarde Howard on Fossil Anseriformes. There is a very useful final chapter of Corrections and Additions, volume by volume, by Delacour which includes new distributional, taxonomical, and avicultural and other data accrued in the intervening years. In addition to the general index, the special indices to this chapter and to the one on Fossil Anseriformes make for convenience of reference.

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[1] Vol. I in *J. Bombay nat. Hist. Soc.* **52** (4): 906, and Vol. III in **57** (1): 208-209.

The thoroughness of the coverage is evident from the bibliographies appended to the various chapters. Under 'The Reproductive Cycle' alone no less than 190 titles of books and papers are listed, under Ecology 170, under Conservation and Management 129, and so on. The excellent section on Conservation and Management (pp. 128-144) contains suggestions which deserve the earnest attention of conservation agencies in our own country—the Indian Board for Wild Life, the State Wild Life Boards and Wild Life Preservation Departments, and the Planning Commission. Many of them could be put into practice, or at least given a fair trial, without considerable extra expenditure in connection with the various multi-purpose dams being constructed throughout the country, and would help to provide refuges for migratory waterfowl during their winter sojourn here. The chapter on 'Anatomy of Waterfowl' (pp. 167-234) is thorough and completely up-to-date. Its bibliography covers 12 pages, broken up usefully under the following subheads: Epidermal System, Osteology, Myology, Respiratory System, Digestive System, Nervous System and Senses, Circulatory System, Urogenital System, and Glands.

The text, as in the previous volumes, is purposely shorn of technical minutiae and professional jargon, as far as possible, so as to be intelligible and interesting to the layman whose main interest in this group of birds is from the sporting and avicultural points of view. The coloured illustrations of all the various forms included in the volumes depict male, female, juvenile, and also eclipse plumages in many instances, and chicks in down which were often unknown till bred at the Wildfowl Trust at Slimbridge. They are equally important with the text—indeed often more so, since many of the species had never been illustrated before. Four of the plates in the present volume have a special appeal. Two illustrate the domestic forms derived from the Greylag Goose, the Swan Goose, and the Muscovy Duck; the other two the variations of the Mallard, and its domestic derivatives. The special coloured plate at p. 332 corrects several of the figures published in previous volumes. This is a useful innovation and, though unfortunate the need, perhaps the only possible way of rectifying such errors and omissions at this stage.

Vol. 4 presents a complete and comprehensive biology of the duck tribe. The series as a whole, simply and authentically written, superbly and meaningfully illustrated, is an encyclopedia of the world's waterfowl, and as such will remain an indispensable vade-mecum alike for the researcher, the conservationist, the aviculturist, and the intelligent sportsman for a very long time to come.

S.A.

5. THE AMAZING WORLD OF INSECTS : A PHOTOGRAPHIC INTRODUCTION. By Arend T. Bandsma and Robin T. Brandt. pp. x+46 (26.5×18 cm.). With 17 coloured and 117 black-and-white plates. London, 1963. George Allen & Unwin Ltd. Price 42*s*.

'Amazing' is the appropriate adjective to qualify the photographs illustrating this fascinating introduction to the world of insects. One cannot help but admire the patience which caught the insects in their natural surroundings and the skill which made of each picture a work of art. A short introduction tells the reader something about insects in general, and equally short descriptive paragraphs give him a few interesting facts about the insect or group of insects portrayed. Technical terms are avoided. Most of the insects shown have their counterparts in India, and the book would be an ideal gift to our young people to interest them in the insects around them.

D.E.R.

6. AQUATIC ANGIOSPERMS. By K. Subramanyam. pp. viii+190 (24×16 cm.). 5 photographs in black-and-white and 63 figures. New Delhi, 1962. Council of Scientific and Industrial Research. Price Rs. 20 or 40*s*. or $6.

This is the third Botanical Monograph published by the Council of Scientific and Industrial Research. The subject of this monograph is very different from that of the previous two and perhaps much more complex. The C.S.I.R. Botanical Monographs Committee being impressed by the wealth of aquatic vegetation and feeling the need for a suitable handbook on the subject, the task was entrusted to the author, who accepted it gladly, as his duties in the Botanical Survey of India gave him ample opportunities to study these plants in nature and in the various herbaria of the country. The author procured the blessings of two Chief Botanists and co-operation from at least two eminent University Professors, three assistants, and three artists. The result of his careful and detailed study for several years is given in this book.

There being no precedent in the present series of monographs the author was left to himself to organise this vast subject. In spite of possible criticism, it must be said that, on the whole, he has acquitted himself well.

In the absence of any circumscription of the word 'Aquatic', the families, genera, and species are well chosen to give the word *sensu lato*. The monograph contains information on 33 families, 68

genera, and 110 species and two varieties of Aquatic Angiosperms of India. At times the choice of the species appears unconsciously biased. For example, when *Alternanthera sessilis* finds a place in the monograph, one wonders why either *Eclipta prostrata* or *Caesulia axillaris* of the same habitat is not included to represent a widely distributed family, the Compositae.

The descriptions of families and genera are given presumably in the sense in which they are currently understood, though no reference other than the author's abbreviated name is indicated. In some cases, however, there are valuable remarks and references after the treatment of the species.

Each species is assigned its valid name, sometimes revised according to the current International Code of Botanical Nomenclature. Important synonyms only are given. It is unfortunate that references to the regional floras are omitted. The economic aspects of various species are drawn from records which may not stand scrutiny in the present conditions. In any case, they do not reveal any great economic importance of this group of plants, nor is there any prospect held out of their utilization. There is hardly any information of value on the ecological aspects of this fascinatingly plastic group of plants. The figures, mostly original but not drawn to scale in every case, form a very valuable feature of this monograph. It might be felt that the printing space taken up by the family and generic descriptions (a significant portion of the monograph) could have been utilised for more figures and elaborate specific descriptions. This reviewer, for example, was struck by the apparent difference in the delineation of the stigmas of *Limnophila aquatica* and *L. indica*, and would have liked to see the detailed description of the two species in the monograph with a possible note on the subject.

A great many very valuable observations on the systematic position are based on morphological evidence leaning rather heavily on embryology. Perhaps it is the current trend of Indian botanists or the influence of the author's 'guru'. However, it must be admitted that the biological data given about various taxa are very useful to students of systematic botany and embryology.

There is no doubt that botanical institutions (including horticultural) and students of Aquatic Angiosperms in India and abroad will welcome this monograph for the wealth of very useful information it contains. The author is to be congratulated on his courage in undertaking this difficult assignment and on his highly creditable execution of it.

P. V. BOLE

Miscellaneous Notes

1. A VISIT TO THE HIGH RANGE, KERALA

I have recently visited the Eruvikulam-Poovar plateau and a part of the Rajamallay Sanctuary in Kerala State for the purpose of seeing and photographing the Nilgiri Tahr. Both places lie within the concession area belonging to the Kanan Devan Hills Produce Company Limited, Munnar, High Range, Kerala. The whole area is so stupendous that it deserves to be more widely known. Not only tahr but also muntjac, elephant, gaur, and sambar can be seen there if you are lucky.

The whole area is preserved by the High Range Game Preservation Association, and during the past four years of rigidly enforced protection the animals, especially the tahr, have made a remarkable comeback. It is now possible to see tahr from the ghat road to Rajamallay Estate. This is a complete sanctuary with a full-time watchman to control the movement of traffic into the sanctuary area. The Eruvikulam plateau, which is opened to licensed shooting, involves walking. However, I was able to get within 40 yards of a herd of tahr and to film them at my leisure. There were about 35 animals in the herd. Even if I had not done this, there were other rewards in the splendid scenery of this high untouched grassland. Of course we were lucky with the weather as we had two beautiful days. November through to March is the best time. For the rest of the year the place is shrouded in mist and rain and nobody goes there.

There is a very comfortable Inspection Hut owned by the K.D.H.P. Co. Ltd. at Eruvikulam. The Company are really the custodians of the area and to them is due the credit for the suppression of poaching as they pay the watchman and patrolmen and underwrite the H.R.G.P.A.

A visit to this area could be combined with a visit to Periyar Lake Sanctuary as the two places are fairly close together. A minimum period of two days is required for visiting Eruvikulam, but Rajamallay can be reached quite easily by car from Munnar. However, the tahr are only seen on the ghat road at present either early in the morning or during the late afternoon. The provision of salt licks when the south-west monsoon is over may keep them on the ghat face for longer periods and bring them close enough to the road for photography.

Fortunately for the future, the Eruvikulam area is unsuitable for cattle- or sheep-ranching as the grass is very coarse and suitable fodder grasses cannot stand the 350-inch rainfall. Neither could any cattle. The area has also been surveyed for forestry and the soil found unsuitable for planting with wattle or other forest crop trees. Therefore it is probable that it will survive inviolate for those who wish to see it. As long as the H.R.G.P.A. maintains its present good control over poaching the Nilgiri Tahr will be there to delight the eye of naturalist, photographer, or genuine trophy hunter.

The Nilgiri Tahr differs from the Himalayan Tahr in not having a long shaggy coat and it does not occupy such inaccessible rocky ledges. When grazing the herds come out on to the open grass-covered slopes above the rocky faces. For this reason it is fairly easy to see them through binoculars and to photograph them with a telephoto lens.

LETHBRIDGE,
ALBERTA, T. H. BASSETT
CANADA,
December 7, 1962.

2. TAXONOMIC STATUS OF *TADARIDA TRAGATA* (DOBSON) [CHIROPTERA : MOLOSSIDAE][1]

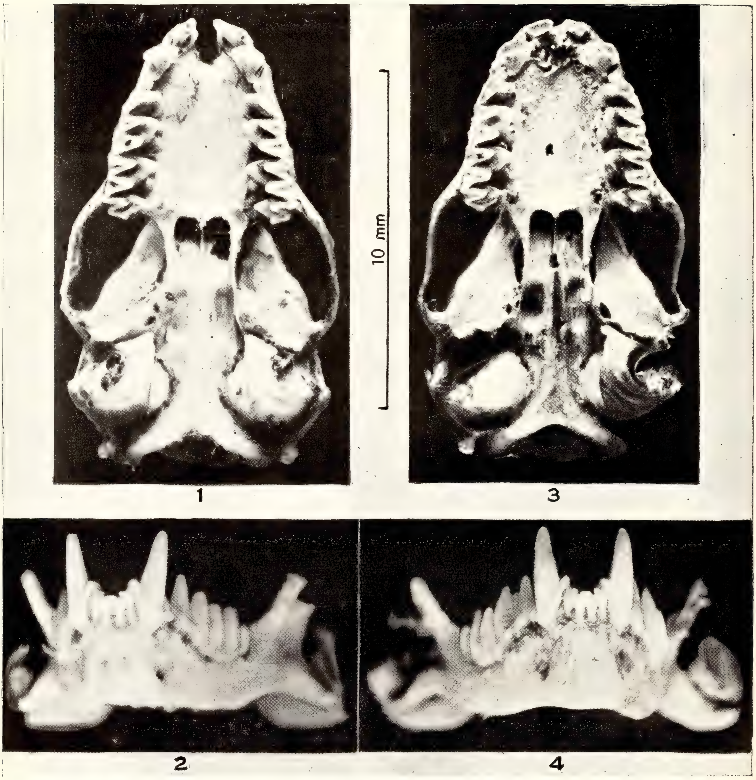
(*With a plate*)

INTRODUCTION

Based on a single specimen, previously identified by Blyth as *Nyctinomus plicatus*, Dobson (1874) described a new species of bat, *Nyctinomus tragatus*, which is now known as *Tadarida tragata* (Dobson). The chief distinguishing characters of *Tadarida tragata* as given by Dobson (1874, 1876) are the absence of the ear-joining band, which separates it from *Tadarida plicata*, and the presence of six lower incisors against four in *Tadarida aegyptiaca* Geoffroy.

Wroughton (1919) pointed out that the specimens of *Tadarida tragata* of the Mammal Survey Collection were found on re-examination to be very closely allied to *Tadarida aegyptiaca*. On these

[1] Communicated by Dr. Biswamoy Biswas, Indian Museum, Zoological Survey of India, Calcutta 13.



Tadarida tragata (Dobson) (holotype) and *Tadarida aegyptiaca* Geoff.

1. Ventral view of skull of *Tadarida tragata* (Dobson), showing anterior premolar (Pm²);
2. Front view of lower jaw of *Tadarida tragata* (Dobson), showing four incisors;
3. Ventral view of skull of *Tadarida aegyptiaca* Geoff., showing the anterior premolar (Pm²);
4. Front view of lower jaw of *Tadarida aegyptiaca* Geoff., showing incisors

specimens he established three new species, which are now considered as three subspecies of *Tadarida aegyptiaca* by Ellerman & Morrison-Scott (1951). Again, Phillips's (1932) specimens of *Tadarida tragata* have recently been found by Hill (1961) to be, in fact, *Tadarida aegyptiaca*. In the light of this information the status of *Tadarida tragata* appears rather confusing, and an attempt has been made here to study the species in detail.

Material and Method

Very few specimens of *Tadarida tragata* are available in the collections of different museums of the world. I could get only four specimens (2 ♂♂ and 2 ♀♀), three (Reg. Nos. 15461, 15462, 15463) in the collection of the Zoological Survey of India and the fourth (Reg. No. 529) received through the courtesy of Prof. K. Zimmermann, Zoologisches Museum der Humboldt Universität, Berlin. The only specimen present in the British Museum was not available owing to its poor condition. All the four specimens have been critically examined and compared with allied species, specially *Tadarida aegyptiaca*, which they resemble very much. Special stress has been given to the characters which have taxonomic importance.

Observations

Ear-joining band

Dobson (1874) separated the species from *Tadarida plicata* on the basis of the absence of ear-joining band in *Tadarida tragata*. Later (1878), he noted a similar condition in *Tadarida aegyptiaca*: 'ears quite separate but close together by the bases of their inner margins'. Hill (1961) mentions that the ears in *Tadarida tragata* unite by the inner margins of their bases. The two similar conditions given above are for two allegedly different species. On examination, however, I found that actually there is no ear-joining band in either species; the ears unite by the inner margins of their bases.

Lower incisors

Dobson (1876) and other authors, apparently following him, have described six lower incisors in *Tadarida tragata* against four in *Tadarida aegyptiaca*. Dobson has stressed this character and separated

the species from *Tadarida aegyptiaca* mainly on this basis. It is interesting to note that Wroughton (1919) and Hill (1961) did not say anything about the number of lower incisors in the Mammal Survey and Phillips's specimens.[1] It is not clear how the Mammal Survey and Phillips's specimens were originally mistakenly thought to possess six lower incisors; they must have had only four as later on they were re-identified as *Tadarida aegyptiaca.* Similarly, the Berlin Museum specimen, which has only four lower incisors, was identified as *Tadarida tragata.* A careful examination of all the specimens, including the holotype (present in the Z.S.I. collection), revealed that they possess only four lower incisors and not six as claimed by Dobson (see Pl., Figs. 2 & 4).

Anterior upper premolar (Pm^2)

Dobson (1874) did not describe the anterior upper premolar. Wroughton (1919) pointed out that in *Tadarida aegyptiaca*, representing the group with four lower incisors, the anterior premolar is reduced to a mere rudiment, and in the other group with six lower incisors (to which *Tadarida tragata* belongs) the anterior premolar though markedly reduced in size is yet a functional tooth. Hill (1961) also notes that in *Tadarida tragata* it is less reduced. In Wroughton's statement it is not certain if he was describing the condition in *Tadarida tragata.* An examination of the available specimens shows that the anterior premolar is reduced to more or less the same extent in both the species (see Pl., Figs. 1 & 3).

As far as the position of the premolar (Pm^2) is concerned, it is similar in both the species, touching the canine cingulum. Moreover, difference of position cannot be considered as a character of specific value for it differs even in different subspecies of *Tadarida aegyptiaca* (Hill 1961).

Size

Dobson (1876) showed some size difference between the two species. According to Wroughton (1919) the measurements given by Dobson do not help much towards identification. Tables 1 and 2 show that there is no appreciable difference in cranial or external measurements where ranges of the two species overlap.

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[1] At our request Mr. J. E. Hill of the British Museum examined the specimen from Malabar in their collection and reports that : ' It has six lower incisors, the inner pair displaced forwards and downwards '. (See also Hill 1961). However he adds : ' It is possible that specimens hitherto referred to *T. tragata* on the ground of the presence of six lower incisors are in fact aberrants of *T. aegyptiaca*, which has normally four : specimens of *T. teniotis* are occasionally encountered with four lower incisors instead of the normal six '.—EDS.

TABLE 1

EXTERNAL MEASUREMENTS (in mm.)

Tadarida tragata (Dobson)

Reg. No.	Locality	Sex	HB	HF	T	TFM	E	FA	Remarks
15461	Calcutta, Bengal	♂	71	9	46	23	20	52	Type, Z.S.I. In spirit
15462	Jaishpur, near Chota Nagpur	♂	74	8	42	22	20	47	Z.S.I. In spirit
15463	Rajanpur, Punjab	♀	74	10	42	20	20	49	do.
529	..	♀	71	9	40	22	18	49	Berlin Museum. In spirit
			Tadarida aegyptiaca Geoff.						
15464	Rajkot, Kathiawar	♂	70	8	45	20	19.5	47	Z.S.I. Dry skin.
15465	Mt. Abu, Rajasthan	♀	69	8	43	23	20	47	do.

Abbreviations : E, Ear; FA, Forearm; HB, Head and Body; HF, Hindfoot; T, Tail; TFM, Tail free from membrane; Z.S.I., Zoological Survey of India

TABLE 2

CRANIAL MEASUREMENTS (in mm.)

Tadarida tragata (Dobson)

Reg. No.	Locality	Sex	C-C	CB	ONL	PL	ZW	Bulla	Mandb.
15461	Calcutta, Bengal	♂	2.5	19.6	19.8	8.4	..	4.4	..
15462	Jaishpur, near Chota Nagpur	♂	2.5	19.1	19.3	8.2	11.7	4.5	13.5
15463	Rajanpur, Punjab	♀	2.5	19.2	20	8.5	12.5	4.4	14
			Tadarida aegyptiaca Geoff.						
15464	Rajkot, Kathiawar	♂	2.5	18.7	19.2	8	11.7	4.2	13.6
15465	Mt. Abu, Rajasthan	♀	2.5	18.5	19	8	11.9	4.4	13.6

Abbreviations : Bulla, Tympanic bulla length ; C-C, Least distance between roots of upper canines ; CB, Condylobasal length; Mandb., Mandibular length ; ONL, Occipitonasal length ; PL, Palatal length ; ZW, Zygomatic width.

In other external characters like distribution of hairs, attachment of membranes, etc., they are very similar. Other authors too agree on the similarities of the external characters of the two species.

Gular Sac

It must be pointed out here that the holotype (♂) of *Tadarida tragata* has a prominent gular sac opening. Dobson (1874) did not mention this character. Probably, being hidden under hairs, it escaped his notice, or he did not give so much importance to its presence. Its presence or absence in *Tadarida tragata* has not been mentioned in the extant literature. However, its absence in *Tadarida aegyptiaca* is frequently mentioned in various publications. It is very interesting to note that the other male specimen (Reg. No. 15462, adult) of *Tadarida tragata* does not possess any gular sac opening. The gular sac may be present either in male or female but its presence is restricted to only one sex within a species, which indicates that it is related to sex. Its secretion helps in attracting the opposite sex. Its presence or absence should, therefore, depend upon the sexual maturity and other physiological phenomena related with breeding.

Literature available on the gular sac is very scanty, and whatever is available does not give any definite support to its taxonomic importance.

Locality

Dobson (1874) mentions Calcutta as the type locality of *Tadarida tragata.* He separated the type specimen from a bottle of specimens of *Tadarida plicata* labelled Calcutta. Later two specimens from Chhutia Nagpur (=Chota Nagpur) and Punjab were collected. But except the type no specimen of *Tadarida tragata* has been reported from Calcutta. Its allied species, *Tadarida aegyptiaca,* is found mainly in western India, i.e. Rajasthan, Kutch, etc., and Sind in W. Pakistan, and has never been reported from Bengal. Hill (1961) has indicated that it is related to *Tadarida teniotis,* not so far represented in the Indian subcontinent[1]. These points make one doubtful about the type locality of *Tadarida tragata.* It might have been due to the mixing of the specimens, and nothing can be said with any degree of certainty about its locality.

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[1] On the status of *Tadarida teniotis* (Rafinesque) in India see *J. Bombay nat. Hist. Soc.* **60** (3) : 723-5.—EDS.

Conclusion

In the light of the abovementioned facts it becomes clear that there is no character which can serve as a basis to distinguish *Tadarida tragata* from *Tadarida aegyptiaca.* Particularly, the presence of only four lower incisors disproves the main distinguishing character of Dobson's *Tadarida tragata.* At the same time it forms a ground to merge *Tadarida tragata* into *Tadarida aegyptiaca.* This suggests that *Nyctinomus tragatus* Dobson should be relegated to the synonymy of *Tadarida aegyptiaca* Geoffroy.

Acknowledgements

I am greatly indebted to Dr. B. Biswas, Superintending Zoologist, Zoological Survey of India, for his valuable suggestions and continuous encouragement throughout this work. My thanks are extended to Prof. K. Zimmermann, Zoologisches Museum der Humboldt Universität, Berlin, for lending me the specimen in his charge.

ZOOLOGICAL SURVEY OF INDIA,
CALCUTTA 13,
May 7, 1964.

Y. CHATURVEDI

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3. A PROTECTIVE DEVICE AMONG WILD ELEPHANTS?

With reference to the note, 'A Curious Protective Device Among Wild Elephants' by Sri K. V. Lakshminarayana in the *Journal,* **60** (1): 250-251, I narrate below an experience I had on 1 April 1964 in the Periyar Wild Life Sanctuary.

At 8 a.m. our boat approached a small herd of elephants which was on a wooded slope close to the water. It consisted of five adults and four young ones. The calves were nicely graded in size, the smallest being a hairy creature not much larger than a buffalo calf. A slightly larger calf also had plenty of hair on its body.

When first seen the animals were feeding in the grass and occasionally flinging earth over their backs. As they formed a nice group and were very close to us, I tried to take a photograph. Within the short time spent in borrowing a camera and examining its 'settings' the elephants deliberately arranged themselves in such a fashion that I could see nothing but the hindquarters of two adults. All the adult elephants had turned away from us and grouped themselves in such a way that the four calves were hedged in among them so thoroughly that we could see nothing at all of the calves!

When the boat started again and moved on, the elephants quietly broke up their 'formation' and began moving away from the water.

Though it was quite clear that the larger animals had bunched up in order to encircle the calves, no animal trumpeted or showed any signs of excitement or fear.

It should also be stated that we came across larger herds with a good sprinkling of very young calves, but these herds did not react perceptibly to the sound or the proximity of the boats.

The party consisted of guests invited to a seminar on American Literature conducted by the U.S.I.S., Trivandrum, and a few members of the U.S.I.S. staff. Sri Parameswaran Nair, of the U.S.I.S., will support the observations given above.

MAHARAJA'S COLLEGE,
ERNAKULAM, KERALA, K. K. NEELAKANTAN
April 20, 1964.

[From a single instance of this kind it is not possible to say for certain that the 'formation' reported by Prof. K. K. Neelakantan was deliberate, particularly so in view of the fact that other herds of elephants took no notice of the boats. Nevertheless, having regard to the experience previously reported by Sri. K. V. Lakshminarayana, the present occurrence is of sufficient interest to be placed on record.—EDS.]

4. NOTES ON INDIAN BIRDS 1—*CEYX ERITHACUS RUFIDORSUS* STRICKLAND IN THE SIKKIM TERAI, EASTERN HIMALAYAS : AN ADDITION TO THE INDIAN AVIFAUNA

While examining the small series of Threetoed Kingfishers *Ceyx erithacus* (Linnaeus) in the Society's collection, I noticed one which was uniformly rufous and washed with lilac on the upper surface and had a large 35.5 mm. bill (from feathers) against 30-33, av. 31.5, in the others. The label was marked 'Male, *Ceyx tridactyla*, Sikkim Terai, 22.7.09, C. M. Inglis' in Mr. Inglis's handwriting. This specimen appeared so different from the others that I sent it for identification to Mr. J. D. MacDonald of the British Museum, who reported that it was *rufidorsus* and referred me to a paper, 'The *Ceyx erithacus* and *rufidorsus* species problem' by R. W. Sims, in the *Journal of the Linnean Society of London, Zoology*, **44** : 212-221 (1959). He also said that, though the bill was longer than in the majority, one or two had them just as long.

Sims examined 351 specimens from various sources and came to the conclusion that the forms *Ceyx erithacus* (Linnaeus) (type loc. : Benghala) and *rufidorsus* Strickland (type loc. : Malacca) are different races of the same species, with varying intermediate stages some of which are constant enough to permit their being separated as races. Typical *erithacus*, according to him, is characterised by:

(i) a blue-black spot on the forehead,
(ii) an ultramarine patch on each side of the neck,
(iii) a black mantle and scapulars washed with ultramarine, and
(iv) black wing-coverts tipped with ultramarine,

while *rufidorsus* lacks all these four characteristics and has the colour of the upper parts uniformly rufous washed with lilac. The eight other specimens available in the Society's collection, from Bombay (3), North Kanara (3), Goalpara (Assam), and Cachar, have all the necessary characteristics of *erithacus*, while the specimen collected by Inglis has none and is uniformly rufous above, washed with lilac.

Sims gives the range of *rufidorsus* : 'throughout the Malaysian subregion in Mindoro and Tawi Tawai in the Philippines and Lombok, Sumbawa and Flores in the Indo-Australian archipelago'.

The race *rufidorsus* does not appear to have been recorded before within Indian limits, the specimen having remained unrecognized for many years.

The examination referred to earlier was prompted by a Threetoed Kingfisher, *Ceyx erithacus erithacus* (Linnaeus) flying into my house

at Bandra, Bombay, at about 8 a.m. on 13 September 1963. It was discovered just as our cat had pinned it against a glass window in the verandah facing west. This species visits the neighbourhood of Bombay as far north as Suriamal, Wada, Thana District, during the monsoon and breeds among the forested hills. It is well known as a wanderer and has often flown into houses—the other two specimens from Bombay were apparently similarly obtained, being marked 'Govt. Dockyard, 18th June 1902' and 'Caught in Bombay. Purchased, 3rd October 1910'.

MESSRS FAIZ & CO.,
75, ABDUL REHMAN STREET,
BOMBAY 3,
July 25, 1964.

HUMAYUN ABDULALI

5. NOTES ON INDIAN BIRDS 2—RACES OF *STERNA ALBIFRONS* PALLAS, IN INDIA AND PAKISTAN

(*With a text-figure*)

ABSTRACT

Ripley's account of the races of *Sterna albifrons* Pallas in A SYNOPSIS OF THE BIRDS OF INDIA AND PAKISTAN (1961) differs from that of Stuart Baker in the FAUNA (1929, **6**). The material and literature available in Bombay indicate that typical *albifrons* breeds along the Persian Gulf to Bhavnagar in Gujarat, and apparently also on the Brahmaputra and the rivers in the Indus basin ; *saundersi* has been obtained in Ceylon and the Maldives, but there is no evidence of its nesting anywhere except around Karachi, Pakistan ; *sinensis* breeds along the coast from China, through Malaya and Ceylon, as far north as Bombay ; *pusilla* is indeterminate.

Stuart Baker in the FAUNA (1929, **6** : 134) accepted 5 races of the Little Tern *Sterna albifrons* Pallas from Indian limits: *albifrons* Pallas (Holland), *sinensis* Gmelin (China), *pusilla* Temminck (Java), *praetermissa* Stuart Baker (Mesopotamia), and *saundersi* Hume (Karachi). Ticehurst (*J. Bombay nat. Hist. Soc.* **34** : 484) merged *praetermissa* with *albifrons* and removed *pusilla* as insufficiently described. Earlier (*Ibis* 1924 : 142) he had merged Hume's *gouldi* (which name incidentally is preoccupied by *gouldi* Reichenbach) with *albifrons*, the form nesting on the rivers of north-west India. Hume (*Stray Feathers* **9** : 131) found *gouldi* nesting at Goalundo on the Brahmaputra.

In 1961, R. S. Dharmakumarsinhji sent to the Bombay Natural History Society the skin of a Little Tern (*Sterna albifrons* Pallas) shot off eggs at Bhavnagar, Saurashtra. An attempt to determine its race by an examination of the skins and literature available in Bombay showed considerable disparity with the position in Ripley's recent A SYNOPSIS OF THE BIRDS OF INDIA AND PAKISTAN and I sent 6 skins to the Berlin Museum for identification. In his reply, Dr. G. Mauersberger stressed the importance of the colour of the shafts of the first three primaries, and the simplicity of the character and the fact that it is constant in non-breeding birds and flying young in juvenile plumage prompted me to attempt a reassessment of the races occurring in India. Additional diagnostic characters are mentioned in the key below and are illustrated by a sketch kindly drawn for me by Miss Elizabeth Reuben. The key is followed by notes on the known distribution of the three races:

(*a*) Shafts of first three primaries dark brown to brownish white. Legs and feet orange-yellow or yellow. Black of head tapers to a point in front, white of forehead touches the eyes. Upper plumage darker than in other two races. ... *albifrons*

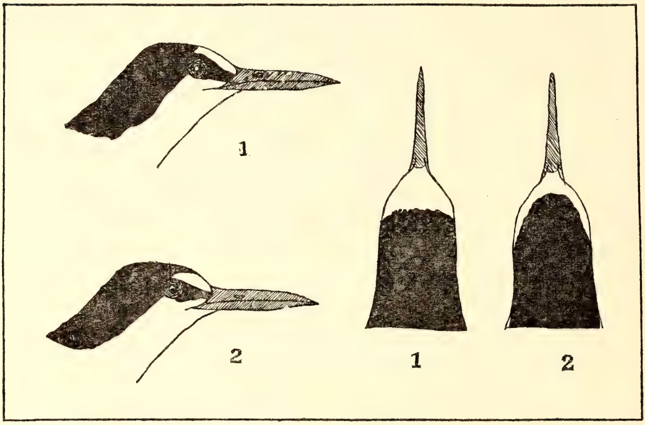
(*b*) Shafts of first three primaries shining white. (Legs and feet and head as in *albifrons*) ... *sinensis*

(*c*) Shafts of first three primaries black (not brown). Grey of upper plumage much lighter than in other two, being most noticeable in two adults obtained on 28-7-1962. Paleness of secondaries sets off and accentuates black in primaries. White of forehead does not reach the eyes. Black on top of head does not taper to a point but has straight edge across forehead. Legs and feet dusky yellowish olive (paler behind and below). According to Stuart Baker (NIDIFICATION **4** : 381) eggs quite distinct from those of the other races. ... *saundersi*

Sterna a. albifrons Pallas The Little Tern.

Ripley (loc. cit.) records the Little Tern as breeding along the Mekran Coast, on a rocky islet off Salsette, Bombay, and at Masulipatam, Andhra. The two latter records are incorrect. The former is based on a nesting colony near Bombay recorded by me in 1939 as of *albifrons* on the strength of an identification by the late Mr. Hugh

Whistler. This seems to have been an unfortunate slip, for the 10 specimens available for examination in Bombay are definitely not *albifrons* and agree with *sinensis*. In the record from Masulipatam there appears to be another slip—Whistler (*J. Bombay nat. Hist. Soc.*



Markings on head of: 1. *Sterna albifrons saundersi*; 2. *S. a. albifrons* and *S. a. sinensis*

39 : 249) specifically stated that he had not had the opportunity of examining specimens and was uncertain of the race, as also of Ferguson's specimen from North Travancore which is recorded as *saundersi* by Sálim Ali (*J. Bombay nat. Hist. Soc.* **39** : 580), but marked with a query in his subsequent (1953) THE BIRDS OF TRAVANCORE AND COCHIN, p. 374.

Ticehurst accepted *albifrons* as the breeding bird in the Persian Gulf and in north-west India, and the Bombay collections include specimens from Mesopotamia (breeding); Kandla, Kutch, (2), 11th September 1943; Salaya, Gulf of Kutch, 6th August 1963; Bhavnagar (breeding), 1st June 1961; Mira Road, Salsette, 6th July 1962; Bombay Harbour, 10th April 1963; and Rewas on mainland opposite Bombay (7, all in non-breeding plumage with dark bills and brown feathers on the shoulders), 27th December 1962. K. S. Shivbhadrasinhji of Bhavnagar found c/3, c/3, and c/2 on Gourishankar Lake, Bhavnagar, in June 1959 (R. S. Dharmakumarsinhji *in epist.*). It is interesting that, with the record from Bhavnagar, the breeding territory of this race

encircles Karachi, the only place where *saundersi* is definitely known to breed.

In the Indian Museum at Calcutta, I saw (March 1964) two old water-damaged specimens from Khan-i-al, Turkestan, and Khwaja Ahmed, Seistan, with the brownish quill shafts of this form.

Sterna a. sinensis Gmelin The Whiteshafted Little Tern.

This race is omitted from Ripley's SYNOPSIS. I have already referred to the nesting colony near Bombay, wrongly recorded as *albifrons*. A visit on 23rd May 1948 showed an active colony of about a hundred nests. On 22nd May 1952, only 3 pairs were seen, together with several drums of 'wash' and a large number of eggshells near the distilling fire-place to tell the tale! Pairs and small parties have been seen at Versova (1st April 1962), Chowpatty (April-May 1962), and Mahim Creek (8th July 1963), but there is no means of being certain of the subspecies. On 25th April 1963, I flew over the island at a height of about 500 ft. and could see no terns at all. The whole island appeared to have been flooded at high tide.

The 10 specimens available, all from the neighbourhood of Bombay, taken between 25th April and 6th September, and all in breeding plumage, have yellow bills with small black tips. The nesting birds of Ceylon and Malaya are now accepted as of this race. Dr. Mauersberger, who examined two specimens from Bombay, thought they were lighter above than the average *albifrons*, though a little darker and less bluish than the true *sinensis*. The latter he opined may be due to staining by blood and fat. In series, they are paler than *albifrons*. In the breeding plumage the bill is yellow with a black tip which is smaller than in *saundersi*. In non-breeding plumage (September), the bills are horny-tipped and not yellow at the base. Dr. Dillon Ripley informs me that he has a non-breeding male taken on the Sankos River in the Eastern Duars in April (Wing 159; Tail 66.5).

Six males from Bombay have wings 168-180 (av. 175) and tails 65-93 (av. 81.6). Dr. Charles Vaurie informs me (*in epist.*) that 10 males of *sinensis* at the American Museum of Natural History, New York, have a wing length of 182-192 (185.5) and outer tail feathers of 95-140 (109). The Indian birds appear to be smaller, but Dr. Mauersberger informs me that 12 skins from China available to him measure 170-187 while individuals from Japan and Luzon are smaller, 164 and 166 mm. Larger series appear necessary to determine if there is any geographic variation in the wide range of this race extending from Japan to Bombay.

Sterna a. saundersi Hume. The Blackshafted Little Tern.

The black (not brown) shafts of the primaries are distinctive. The grey of the upper parts is much lighter than in *albifrons* and *sinensis*, being most noticeable in two adults obtained on 28th July 1962.

Ripley (loc. cit.) notes it as breeding along the coast of West Pakistan as far east as Karachi, and on Karativu Island, north-west of Ceylon. Hume described this from Karachi and referred specimens from the Laccadives, Ceylon, Madras, as well as a nestling from Phillor on the Sutlej, to this race! Ticehurst & Cheesman (*Ibis* 1925: 29) referred to a pair and a single bird secured at Bahrain Island, and another caught exhausted off the Hadhramaut Coast on 8th May 1923. They suggest that this race breeds at the southern end of the Persian Gulf, the breeding bird at the northern end being *albifrons*.

Ticehurst (*Ibis* 1924 : 143) states that it appears in Karachi about the first week in April and disappears by the beginning of September. The specimens available are from Karachi (breeding), 16th April and 9th July; Salt Works, Kandla, Kutch, 6th and 9th May (2), 16th July; Pirotan Island, Gulf of Kutch, 28th July 1962 (3). One bird marked *saundersi* by Ticehurst (Karachi 15th April 1918) has the black forehead and the first primary shaft as in *albifrons* and is no doubt of the latter race.

Phillips in A REVISED (1952) CHECKLIST OF THE BIRDS OF CEYLON, also quoted by Ripley, refers to 3 specimens obtained on Karativu Island, but does not say that they are from a nesting colony. Again he refers to three specimens (*J. Bombay nat. Hist. Soc.* **55** : 221) shot in the Maldives in January and adds 'resident' as it was 'reported to breed'. This race, as also the others, travel long distances in the non-breeding season, but there appears to be no definite evidence of its nesting anywhere except around Karachi. Bulkley's record from Kharaghoda (*J. Bombay nat. Hist. Soc.* **8** : 325) is quoted as of this race, but it may be well to check upon its correctness. It is curious that there is no record of this race south of the Gulf of Kutch, i.e. on passage to Ceylon.

Hartert & Steinbacher (1932) have drawn attention to several instances of misidentification of *albifrons* as *saundersi* in African limits, and it is necessary to examine the records more carefully. If the breeding records from Ceylon are confirmed, it will be necessary to separate this as a species as already suggested by Stuart Baker (NIDIFICATION **4** : 381) and Hartert & Steinbacher (loc. cit.).

Ticehurst stresses the fact that *saundersi* is a salt-water bird and its colonies are scattered over a fairly large area, so that each nest is some distance—twenty to a hundred yards—from the next. The

nests of *sinensis* near Bombay were only a few feet apart. Ticehurst also said that as soon as one reached the Indus the Little Tern (*albifrons*) was the nesting form, which never breeds on maritime shores. This is not correct, for in Europe and North Africa *albifrons* is known to nest on the seashore.

In India, *sinensis* has only been recorded as nesting near the sea but La Touche (HANDBOOK OF THE BIRDS OF EASTERN CHINA **2** : 330) refers to clutches of 2 and 3 along the coast and on river banks. In the non-breeding season of course, all three may be found over salt water.

Sterna a. pusilla Temminck.

Ripley (loc. cit.) has accepted this as the river-breeding tern in India, but I have already referred to Ticehurst's earlier opinion based on (1) absence of specimens, (2) insufficient description, and (3) type locality being in Java where *sinensis* is now accepted as the breeding form, and agree with Ticehurst that it would be best to drop this name.

Stuart Baker's key for the identification (loc. cit. p. 134) of the five races mentioned by him divides them into two groups, one (*albifrons* and *sinensis*) with 'bill larger, culmen 28-34 mm., much stouter' and the other (*praetermissa*, *pusilla*, and *saundersi*) with 'bill smaller, culmen 26-32 mm., much more slender'. Birds of the year appear to have smaller dark-coloured bills as compared with the yellow bills of birds in breeding plumage and I have been unable to associate these differences with any of the races.

ACKNOWLEDGEMENTS

This note is based on an examination of some 40 skins which include 15 in the collections of St. Xavier's High School, Bombay. I am grateful to the school authorities for having permitted their examination and also for presenting 4 skins to the Society. Dr. Sálim Ali very kindly let me have a translation of relevant portions from Hartert & Steinbacher, which has been useful in completing some parts of this note. Drs. G. Mauersberger and Dillon Ripley kindly read over the draft note and I am grateful for their suggestions.

MESSRS FAIZ & CO.,
75, ABDUL REHMAN STREET,
BOMBAY 3,
July 25, 1964.

HUMAYUN ABDULALI

6. NEW BIRD RECORDS FOR SAURASHTRA

1. Red Kite [*Milvus milvus* (Linnaeus)]

On 23-3-64 at a lake near Jasdan I saw a Red Kite, *Milvus milvus* (Linnaeus), sitting on the mudflat. The lighter-coloured head, dark-streaked brown breast, and rufous underparts and tail were distinctive and put it apart from the Common Pariah Kites which were also there. I was able to watch the bird for 15 minutes through binoculars before it flew off on my going closer. The only other record for India is that of Dr. Sálim Ali at Pung Bet in the Rann of Kutch where over 50 were observed in March 1945.

2. Large Crowned Leaf Warbler [*Phylloscopus occipitalis* (Blyth)]

During the BNHS/WHO Bird Migration Study camp at Hingolgadh in September 1963, a single Large Crowned Leaf Warbler [*Phylloscopus occipitalis* (Blyth)] was caught in a mist net on 19-9-63. This bird has been recorded from Gujarat but there are no records of its occurrence in Saurashtra.

3. Masked Wagtail (*Motacilla alba personata* Gould)

On 9-1-1964 I saw a Masked Wagtail (*Motacilla alba personata* Gould) at Jasdan. This bird has not been previously recorded from Saurashtra.

THE PALACE,
JASDAN,
February 23, 1964.

Y. S. SHIVRAJKUMAR

7. SOME NOTES ON THE PAINTED PARTRIDGE [*FRANCOLINUS PICTUS* (JARDINE & SELBY)] AROUND BOMBAY

The Painted Partridge [*Francolinus pictus* (Jardine & Selby)] is resident in the Bombay Konkan and is the only game bird which affords regular sport in that area. As little or nothing has been noted about its food and other habits, the few notes which I have retained over many years may be worthwhile recording.

This bird ordinarily lives in heavier cover than the Grey Partridge (*F. pondicerianus*) which does not occur in the Konkan and is only found beyond the Ghats in the Deccan. Unlike the Grey Partridge, it does not collect in coveys. When approached, unlike the Grey and

the Black (*F. francolinus*), it does not run along the ground from bush to bush through open country, but squats in cover, often unbelievably scanty. It calls only during the courting and breeding season, the earliest calls noted being on 8 and 15 April and the last on 4, 7, and 15 October[1]. The call, which is uttered only by the male, has been syllabilised as *chee-kee-kerrag* and can be heard at long distances. At short range a preliminary *click* is audible. The bird may call at any time of the day, though more often in the morning and in the evening. The call is uttered, in our area at least, only from trees or other prominent positions—I have heard it calling from an electric pylon. When calling it can usually be approached, and I fear that some are shot in this manner.

The Small Game Season in Maharashtra is from 1 October to 31 March which, in my opinion, is correct for this species. Though all the broods may not be fully grown in October, it is impossible to do any shooting until the rice has been harvested and the grass also cut, i.e. by early December, when young birds with yellow legs are rarely seen. In February and March, two birds may occasionally be put up out of the same patch, but I do not think that they pair off so soon. In the Deccan the Grey Partridge and the Common Sandgrouse (*Pterocles exustus*) commence breeding by February and the Small Game Season, which is now common for all birds, will have to be adjusted.

Though larger bags have been reported, the Painted Partridge is not easily put up and 10-12 brace to 2 or 3 guns is the most I have seen shot. They offer excellent sport but can only be put up with a line of beaters, who must really 'beat about the bush'. Famous dogs, brought out by friends, have quickly and invariably produced a strong desire in all, except the owner, to shoot them!

Before the restrictions imposed under the Bombay Wild Animals and Wild Birds Protection Act, 1951, large numbers were netted for the market in the surrounding countryside, resulting in a heavy toll of their numbers. With such control as it has been possible to exercise over the activities of the Phansi Pardas (a tribe of professional trappers) the number of birds has no doubt increased, but this has been largely off-set by deforestation and the disappearance of scrub cover. In many places where it was once possible to have a long beat of 300 or 400 yards, only a few stray bushes are left forcing the birds to move further away.

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[1] Heard on 5 November 1964.—H. A.

Some years ago I was struck by the occasional disparity in the number of males and females in the day's bag, e.g. of 17 birds shot over 6 days in different places between October and February, 14 were males. I therefore decided to check further bags but, as 10 shot in December included 6 males and another 10 in January were 5 males and 5 females, my inquiry was suspended until another day when of 15 birds sexed 11 were males.

A few notes of one day's shooting are as under:

		♂♂	♀♀
11 shot in December at	M:	10	1
10 do.	M:	2	8
5 shot in March at	A:	..	5
3 do.	B:	1	2
5 do.	C:	2	3
5 do.	D:	1	4

The overall figures for 220 sexed at 31 shoots showed 113 males and 107 females. Though this did not indicate any disproportionate number of males and females, I sent the above-quoted figures to Mr. S. D. Jayakar, Genetics and Biometry Laboratory, Bhubaneswar. From his reply it appears that the numbers are not consistent with random sampling and that one would get such a scatter of ratios by chance less than once in a hundred trials. A possible explanation is that males prefer one area at one time and females another, though it is difficult to imagine why this should be. Here is a problem to which shikaris may give some attention. The female can ordinarily be told by the chin being white and less heavily streaked than the male, but this is not infallible and the only certain method is to sex the bird by dissection.

There is another interesting observation about the Painted Partridge. The country where it is found also holds the Jungle Bush Quail (*Perdicula asiatica*) and the Bluelegged or Common Bustard Quail (*Turnix suscitator*) and, during the season, the Grey Quail (*Coturnix coturnix*) and the Rain Quail (*Coturnix coromandelica*). The beat may produce any of these birds, but a few years ago I noticed that, if a patch held Bush Quail, no Painted Partridge would be present. I have had this in mind over several seasons and can now confidently state that these two will not be found in the same cover. Considering that the other quails may often be found with the Painted Partridge, one can only assume that there is some form of antipathy between the Painted Partridge and the Jungle Bush Quail. It may happen that a patch beaten in the morning may produce either the

Bush Quail or the Painted Partridge and, worked over again later, would reveal the exact reverse—but never the two together. I have seen the Bustard Quail beaten out of the same patch as the Bush Quail. It would be interesting to have the experience of persons from other parts of the country.

The main crop in the Konkan is rice and there is no doubt that this forms an important part of the food of this bird. The best sport is also available in rice stubble adjoining scrub jungle. It will not be found far from fresh water and has often been put up out of tall rushes during the course of snipe shoots—Job's Tears (*Coix lachryma-jobi*) seeds have been found in its stomach. There is some local migration due presumably to conditions of food and cover. Paddy gleanings form its staple diet in November, December, and January, though a greater proportion of large black ants (*Camponotus* sp.), Chrysomelid Beetles (*Aulacophora foveicollis*, 30-40 at a time), and large Pentatomid Bugs (*Aspongopus janus*) is taken later in the season. A large Tenebrionid beetle (*Pseudoblaps mellyi* Mal.) was found in December.

I have also been shown small 'canopies' 8 to 10 inches high formed by constant use in patches of standing dry grass which are said to be roosts of individual partridges. The last one examined held 6 to 8 droppings, and a partridge was flushed a short distance away.

MESSRS FAIZ & CO.,
75, ABDUL REHMAN STREET, HUMAYUN ABDULALI
BOMBAY 3,
July 2, 1964.

8. ADDITIONS TO THE BIRDS OF KUTCH : *MONARCHA AZUREA* (BODDAERT) AND *MUSCICAPA THALASSINA* SWAINSON

The countryside surrounding the Vijaya Vilas Palace at Mandvi, which includes the plantation around the palace, other cultivated gardens, the sea-shore, the salt-water creeks, and the mudflats, is a veritable paradise for bird watchers, particularly during the cold weather. In January this year I was again lucky to discover two new birds in the garden there.

I saw a Blacknaped Blue Flycatcher (*Monarcha azurea*), either a female or an immature male, since it had a faint crescentic bar on its throat, on the morning of January 13. In the evening of the same day I came across the second new bird, a Verditer Flycatcher (*Muscicapa thalassina*), which was a male. I saw the former again on February 13.

About the former, Whistler (POPULAR HANDBOOK OF INDIAN BIRDS) says: 'The Indian race, *H. a. styani*, which also extends eastwards to Hainan, occurs throughout the whole country except north-west of a line from Lucknow, Sehore and western Khandesh.' Dharmakumarsinhji (BIRDS OF SAURASHTRA) says that it is a rare straggler into Saurashtra, having been recorded in Chānch. Dr. Sálim Ali recorded it at Dwārka which is not so far from Mandvi as the crow flies. Sálim Ali and Whistler say that *Muscicapa thalassina* is found all over the Indian Union in winter excepting the drier portions of Rajasthan.

JUBILEE GROUND,
BHUJ,
KUTCH,
April 12, 1964.

M. K. HIMMATSINHJI
Member of Parliament (Lok Sabha)

9. RECOVERY OF RINGED BIRDS

Ring No. and species	Date and place of ringing	Date and place of recovery	Remarks
C-326 *Anas crecca* ♂	6.2.1964. Manjhaul (*c*. 25.23 N., 86.30 E.), Monghyr Dist., Bihar	1.5.1964. Killed by man near Kormilovka (55.00 N., 74.05 E.), Omsk Region	Reported by the Bird-Ringing Bureau, USSR Academy of Sciences, Commission for Nature Protection, Moscow, USSR.
C-380 *Anas querquedula* ♀	4.4.1962. Bharatpur (*c*. 27.13 N., 77.32 E.), Rajasthan	10.10.63. Killed by man, Temir-Tau (50.05 N., 72.55 E.), Kazakh, SSR, Karaganda Region	do.
F-3529 *Anas crecca* ♀	15.2.1964. Manjhaul (*c*. 25.23 N., 86.30 E.), Monghyr Dist., Bihar	3.5.1964. Killed by man, 30 km. W. of Petrovsk-Zabaykalskiy (51.15 N., 108.50 E.), Chita Region	do.
F-3563 *Anas clypeata* ♀	18.2.1964. do.	6.5.64. Killed by man, Abagay-tuy (49.35 N., 117.45 E.) Borzya, Chita Region	do.
A-58509 *Motacilla flava thunbergi*	21.1.64. Edanad (*c*. 9.20 N., 76.38 E.) Chenganoor, Kerala	14.5.1964. Found dead, Karabas (49.30 N., 72.55 E.), 40 km. SW. of Karaganda, Kazakh, SSR	do.
C-149 *Anas crecca* ♂	18.2.1964. Manjhaul (*c*. 25.23 N., 86.30 E.), Monghyr Dist., Bihar	29.5.1964. Killed by man, near Boguchany (58.20 N., 97.30 E.), Krasnoyarsk Region	do.
C-387 *Anas querquedula* ♀	4.4.1962. Bharatpur (*c*. 27.13 N., 77.32 E.), Rajasthan	3.9.1963. Killed by man, near Ishimbay (53.30 N., 56.05 E.), Bashkirien (Bashkir, ASSR)	do.
C-2071 *Anas crecca* ♀	3.2.1964. Manjhaul (*c*. 25.23 N., 86.30 E.), Monghyr Dist., Bihar	14.5.1964. Killed by man, near Sosnovo-Ozerskoe (52.30 N., 111.20 E.) Buryat, ASSR	do.

All these birds were ringed in the course of BNHS/WHO Bird Migration Field Project.

Bombay Natural History Society,
91, Walkeshwar Road,
Bombay 6-WB.,
August 25, 1964.

EDITORS

10. A SUPPLEMENTARY NOTE ON 'A LIST OF THE REPTILES AND AMPHIBIANS OF THE SURAT DANGS, SOUTH GUJARAT'

In the December 1963 number of the *Journal* (**60** : 737-43), Mr. J. C. Daniel and I reported forty species of reptiles and amphibians from the Surat Dangs. In the meantime, I have collected two more species of reptiles in this area, as follows:

Family AGAMIDAE

Calotes rouxi Dum. & Bibr. 1837

Fairly common. The recorded distribution is Bombay Presidency (Matheran, Khandala, Kanara, Jog); Travancore.[1] Its presence in the Dangs represents a northern range extension.

[The Society's collection has specimens from Suriamal, north Thana and Ghoti, Nasik District.—EDS.]

Family SCINCIDAE

Mabuya macularia (Blyth) 1853

Fairly common. Found among vine-covered rocks at riverbanks and in fence rows.

AHWA, VIA BILLIMORA,
DANGS DISTRICT,
GUJARAT STATE,
May 15, 1964.

E. M. SHULL

11. OCCURRENCE OF A SCALE INTERPOSED BETWEEN THE PARIETALS AND OCCIPITALS IN THE KING COBRA, *NAJA HANNAH* (CANTOR)

Smith (FAUNA BRIT. INDIA, Reptilia, and Amphibia **3** : 437, 1943) has made the following remarks in connection with the lepidosis of the head in the King Cobra, *Naja hannah* (Cantor).

'Boulenger (F.B.I.) and de Rooij both figure the head with a small scale interposed between the parietals and occipitals. It is evidently a rare character. I have seen it in a specimen from S. Canara, and Prashad records it in another.'

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[1] Smith, M. A. (1935) : FAUNA OF BRITISH INDIA, Reptilia and Amphibia **2** : 207.

During my study of Indian poisonous snakes I examined six specimens (three adults and three juveniles) of *Naja hannah* preserved in the Zoological Survey of India. Three out of these, viz. one adult from Botanical Gardens, Calcutta (Regd. No. 8292) and two juveniles (locality unknown) have this scale.

It thus appears that this character is not so rare as suggested by Smith.

ZOOLOGICAL SURVEY OF INDIA,
34, CHITTARANJAN AVENUE, K. K. TIWARI
CALCUTTA 12,
March 9, 1964.

[Among the 14 specimens in the Society's collection two—No. 2275, Kachugaon, Dubri Div., Assam, and No. 2280, Quilon, Kerala—have the additional scale on the head. Both are adults.—EDS.]

12. OCCURRENCE OF THE OBLONG SUNFISH [*RANZANIA TRUNCATA* (RETZIUS)] IN BOMBAY WATERS[1]

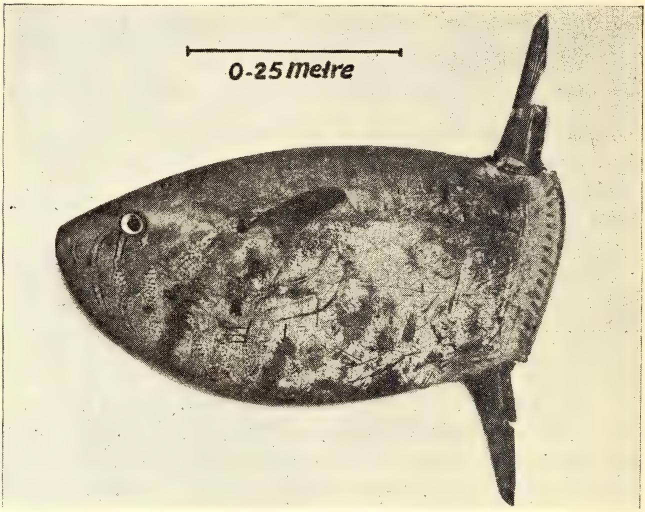
(*With a photograph*)

A specimen of the sunfish was caught on the hook by a fisherman at Sassoon Dock (Bombay City) in March 1964. Not having come across such a fish before, he kept it in ice overnight. The next day it was brought to the Taraporevala Aquarium where it was identified as the Oblong Sunfish, *Ranzania truncata* (Retzius).

The family Molidae is represented in the world by three genera—*Mola*, *Masturus*, and *Ranzania*. The first is represented by the Giant Ocean Sunfish *Mola mola* (Linnaeus) which grows to more than eight feet. The genus *Masturus* is represented by the Pointedtailed Sunfish *Masturus lanceolatus* (Lienard). This can be easily distinguished from *Mola mola* by the asymmetrical pointed tail and by the presence of a coloured band running between the dorsal and anal fins. *Ranzania* differs from these two genera in its longer body, its depth being contained twice in its length (as against 1 to $1\frac{1}{2}$ for the other genera), and also by its gill-rakers being free (not buried in the skin). The skin is smooth.

[1] Communicated by the Director of Fisheries, Maharashtra State.

Kulkarni (1953)[1] has reviewed the records of sunfishes in Indian waters. Although they are members of the off-shore tropical and temperate marine fauna of the world, they are never very common.



The Oblong Sunfish *Ranzania truncata* (Retzius)

Apart from three specimens recorded from Ceylon by Deraniyagala (1944) and one from the Malabar coast by Chacko & Mathew (1956), the Oblong Sunfish has not been caught in our waters. The capture of the present specimen has therefore provided an opportunity for examination in a comparatively fresh state. A short description of the fish is given below.

Ranzania truncata (Retzius)

Tetrodon truncatus Retzius, *Vet. Ak. Nya Handl.* **6** (2) : 116 (1785).
Balistes truncatus Pennant, Outlines of the Globe **1** : 213 (1798).
Orthagoriscus truncatus Pearson, *Spolia Zeylanica* **7** : 208 (1911).
Ranzania truncata Barnard, *Ann. S. Afr. Mus.* **21** (2) : 989 (1927) ; Barnard, ibid. **30** (5) : 657 (1935) ; Norman & Fraser, Giant fishes, whales & dolphins : 184 (1937) ; Chacko & Mathew, *J. Bombay nat. Hist. Soc.* **53** (4) : 724 (1956); Nikol'skii, Special Ichth. (2nd Ed.) : 474 (1961).

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[1] Kulkarni, C. V. (1953) : Rare Ocean Sun-Fish—*Masturus lanceolatus* Lienard in Bombay waters. *J. Bombay nat. Hist. Soc.* **51** : 948-50.

Ranzania laevis Whitley, *Rec. Austr. Mus.* **19** (1) : 108 (1933) ; Deraniyagala, *J. Bombay nat. Hist. Soc.* **44** (3) : 429 (1944) ; Munro, Mar. & Freshwater Fishes of Ceylon : 284 (1955).

Ranzania makua Jenkins, *Proc. Cal. Ac. Sci.* **2** (V) : 780 (1895) ; Jordan & Evermann, *Bull. U. S. Fish Comm.* **23** (1) : 440 (1905) ; Snyder, *Proc. U. S. Nat. Mus.* **44** : 455 (1913) ; Scott, Marine & Freshw. Fishes of South Austr.: 301 (1962).

Ranzania typus Fraser-Brunner, *Ann. Mag. nat. Hist.* (2) **10** : 7 (1943) ; Smith, Sea Fishes of South. Afr. : 422 (1953).

The body is greatly compressed but elongate, the depth being contained twice within the length. The skin is smooth. The mouth is covered by flaps of skin on each side to form a funnel. The teeth are fused to form a plate in each jaw, the latter not extending beyond the rounded profile of the body. The gill-rakers are free. An air bladder is absent, and so are the pelvic fins. The skin below the elongate pectoral fins is depressed so that these fins lie flush against the body. Their axis lies above the level of the centre of the eye. The tail is gephyrocercal; its border is slightly undulating, giving it a scalloped appearance.

MEASUREMENTS

Characters		*Measurement in mm.*
Standard length	..	528
Total length	..	571
Depth of body	..	290
Length of snout (from front of orbit to mouth)	..	72
Transverse diameter of orbit	..	34
Longitudinal diameter of orbit	..	30
Interorbital width	..	64
Height of dorsal fin	..	180
Height of anal fin	..	170
Length of pectoral fin	..	119
Length of caudal fin	..	43
Height of caudal fin	..	220
Distance between tips of dorsal and anal fins	..	547

Weight 6.5 kilograms

Colour in the fresh fish dark steel-grey above, merging to silver on the sides and belly. This silvery sheen is easily rubbed off by handling, then exposing a fleshy pink with a honeycomb design of slightly darker red. On preservation, the body turns a uniformly dark grey. The sides of the head below the eyes have parallel silvery stripes with black borders, extending backward as gradually diminishing stripes on the belly.

The tail, which is pinkish brown, has approximately eighteen

finger-shaped dark spots at right angles to its border; these indicate the positions of the fin-rays below the skin.

The network of bright silver bands, with small black spots, enclosing oval patches of dull greyish silver, and irregular dark marks on the back and hind end of the body, described by Barnard (1927), are not indicated in the present specimen.

The specimen will be deposited in the collections of the Zoological Survey of India.

The author is grateful to Dr. C. V. Kulkarni, Director of Fisheries, Maharashtra State, and Dr. H. G. Kewalramani, Senior Scientific Officer, for facilities at the Taraporevala Marine Biological Station.

TARAPOREVALA MARINE BIOLOGICAL STATION,
BOMBAY 2, B. F. CHHAPGAR
July 27, 1964.

13. A PRELIMINARY ACCOUNT OF THE FLATFISHES (HETEROSOMATA) FOUND ALONG THE BOMBAY COAST[1]

The flatfishes (Heterosomata) are well represented in the catches along the Bombay coast and as many as fourteen species have so far been recorded in the samples of catches obtained during the years 1957-58 from Okha to Malvan. Out of these, the occurrence on this stretch of coast of three species, *Pseudorhombus elevatus* Ogilby, *Brachirus commersoni* (Lacépède), and *Paraplagusia blochii* (Bleeker), is being recorded here for the first time. A list of flatfishes of Bombay, with a brief account of the variations from previous descriptions with reference to the morphometric and meristic characters, is given below.

SYSTEMATIC LIST OF FLATFISHES OF THE BOMBAY COAST

Family PSETTODIDAE

Psettodes erumei (Schneider) *Marathi*, Bhakas ; *English*, Indian Turbot
D. 47-54, A. 35-41.

Common in trawl catches throughout the year. In small numbers in the inshore waters from September to October.

Hab. East Africa to the Pacific.

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[1] The area studied and reported on includes the coasts of Maharashtra and Gujarat States.

Family BOTHIDAE

Subfamily PARALICHTHINAE

Pseudorhombus arsius (Ham.-Buch.) *Marathi*, Lepti, Lep.

Specimens from Bombay, Veraval, and Okha.

Hab. East Africa to Pacific.

Pseudorhombus elevatus Ogilby

D. 76-78, A. 57-60, Lt.l. 67-68.

Numerous specimens were collected from wall-nets, locally known as *wana*, during the period December to March on different shore-strips. They were not so common in other months and hence are not of much commercial significance.

Hab. From the Persian Gulf, through the Indian Ocean and Archipelago to Australia.

Pseudorhombus javanicus (Bleeker)

Hab. East Coast of India to Malay Peninsula and Archipelago.

Family SOLEIDAE

Brachirus commersoni (Lacépède)

D. 74-79, A. 60-67.

Depth $3\frac{1}{2}$ to 4, head $5\frac{1}{3}$ to 6, in length; diameter of eye 7 to 10 in length of head. Right pectoral 5 to 7 in length of head. Scales about 155 to 160 in longitudinal series.

Specimens from Bombay and Ratnagiri.

Hab. Seas of India to Malay Archipelago.

Brachirus orientalis (Bloch & Schneider)

Specimens from Jaitapur, Malvan, Bombay, Satpati, and Okha.

Hab. From the Persian Gulf, through the Malay Peninsula and Archipelago, to China and Australia.

Zebrias quagga (Kaup) *Marathi*, Sudi ; *English*, Sole

Specimens from Bombay and Satpati.

Hab. Seas of India, throughout the Malay Peninsula and Archipelago to China.

Aseraggodes cyaneus (Alcock)

Hab. From the Persian Gulf, through the Indian Ocean and Archipelago to the Timor Sea.

Family CYNOGLOSSIDAE

Paraplagusia bilineata (Bloch) *Marathi*, Shivra ; *English*, Sole

Specimens from Kodinar.

Hab. From East Africa, through the Indian Ocean and Archipelago to China and Japan.

Paraplagusia blochii (Bleeker)

Specimens from Okha and Kodinar.

Hab. East Africa, throughout the Indian Ocean and Archipelago to Formosa.

Cynoglossus bilineatus (Lacépède)

Specimens from Kodinar, Umarsadi, Kolak, Bombay, and Mithbao.

Hab. From the Red Sea, through the Indian Ocean and Archipelago, to Australia and Japan.

Cynoglossus dispar Day

D. 110-112, A. 88-90.

Depth $3\frac{1}{5}$ to $3\frac{3}{5}$, head $4\frac{1}{2}$ to $4\frac{4}{5}$, in length. Snout $3\frac{2}{5}$ to $3\frac{1}{2}$ in head. Diameter of eye 9 to 10 in head, almost equal to interorbital width; scales 106 to 112 in longitudinal series; two lateral lines on ocular side, separated by 19 to 20 series of scales, two on blind side separated by 23 to 26 series of scales.

Specimens from Bombay.

Hab. Bombay; Madras.

Cynoglossus dubius Day

D. 103-115, A. 84-91.

Depth $3\frac{3}{5}$, head about 4, in length. Snout $2\frac{2}{5}$ in head, diameter of eye 12 in head; two lateral lines on ocular side separated by 20 series of scales.

Specimens from Bombay and Satpati.

Hab. Sind and Baluchistan, Travancore.

Cynoglossus lingua Ham.-Buch.

Few specimens from the trawl catches off Bombay coast.

Hab. Coasts of India to Malay Peninsula and Archipelago.

Cynoglossus macrolepidotus (Bleeker)

Common in the catches along this coast but not of much commercial importance.

Hab. Persian Gulf, seas of India, Malay Peninsula and Archipelago; China.

Cynoglossus puncticeps (Richardson)

Specimens from Bombay and Gholvad.

Hab. From Sind, through the Indian Ocean and Archipelago to China.

TARAPOREVALA MARINE BIOLOGICAL
RESEARCH STATION,
BOMBAY 2,
December 17, 1963.

M. J. PRADHAN[1]

14. ON THE ABILITY OF *GLYPTOTHORAX TELCHITTA* (HAMILTON) TO SURVIVE OUTSIDE WATER

During a study of the fish fauna of the upper Gangetic plain, I came across an extraordinary case of the ability on the part of *Glyptothorax telchitta* (Hamilton), a fish belonging to the family Sisoridae and locally known as *tilier*, to survive outside water.

On 20 December 1960 I went with some fishermen to Kalinadi (a small stream flowing along the western border of Muzaffarnagar town) to observe the catch and to collect fish for my work. At about 11 a.m. a solitary *Glyptothorax telchitta* (Hamilton) was netted and I asked the fisherman to keep it separately for me in his basket. At about 3 p.m., when the fishing was over, I selected some more fish, put them all in a paper bag, and reached the laboratory at 3.45. At about 4.30 I took the whole lot of fishes and placed them in a sink for washing. As I opened the tap, I saw, to my surprise, that *G. telchitta* was still alive. I separated it from other fish and put it in flowing water (a sink full of water with an overflow arrangement). I found that the fish regained its normal activity and to all appearances was none the worse for its ordeal of more than 5½ hours outside water. It was perfectly normal and healthy even after five days when I fixed the whole fish in Bouin's fluid for histological examination.

No accessory respiratory organs are known to exist in this species, nor were any discovered on a careful examination. It was noted, however, that all the barbels, the characteristic adhesive pad on the ventral side, and the lips were blood-red in colour after 5½ hours' stay outside water. This indicates that all these parts were suffused with an unusual supply of blood to enable them to allow gaseous exchange with the atmosphere necessary for maintaining at least the minimum respiratory activity required for survival. This process may probably be supplemented by the gills by gasping air through the

[1] Present address : Central Marine Fisheries Research Centre, Veraval, Gujarat

mouth. These factors, along with the fact that the general metabolism of the fish is at a low ebb during winter, may have contributed a good deal to this extraordinary ability. In about 12-15 hours the colour of the parts which had become blood-red at the time of putting the fish in flowing water became normal.

Whether this is an instance of exceptional capacity on the part of the individual or is a characteristic of the species is not clear, but a possible significance of this phenomenon in nature may be found in the ecology of the torrential streams which constitute the natural habitat. It is possible that the rapid current of the streams might some time throw these fishes out of water, or a rock to which they might be attached may suddenly become exposed for some time due to the lowering of the water level or shifting of the current. In such an emergency the ability to survive outside water would be a great advantage in the struggle for existence.

Grateful thanks are due to Dr. V. P. Agrawal, Head of the Zoology Department, D.A.V. College, Muzaffarnagar (U.P.), for providing facilities.

Zoology Department,
Rajasthan University, C. L. MAHAJAN
Jodhpur,
August 24, 1962.

15. A NEW SPECIES OF *STENOCRANUS* : *S. AJMERENSIS* SP. NOV. (ARAEOPIDAE : FULGOROIDAE : HOMOPTERA : HETEROPTERA)[1]

(*With a plate*)

Male

Length 4.3 mm. (approximate).

Vertex, pronotum and mesonotum stramineous; mesonotum stramineous suffused with ochraceous; the area between the lateral and median carinae of frons dark black; the carinae on the ventral side of head stramineous; the area outer to the lateral carinae and inner to the outer carinae and the clypeus pale brown; the remaining part of the ventral side of head ochraceous. Antennae ochraceous. Ventral side of thorax ochraceous, legs stramineous with castaneous streaks. Tegmen (Plate, fig. 4) subhyaline, distally the veins pale brown. Abdomen ochraceous marked with castaneous.

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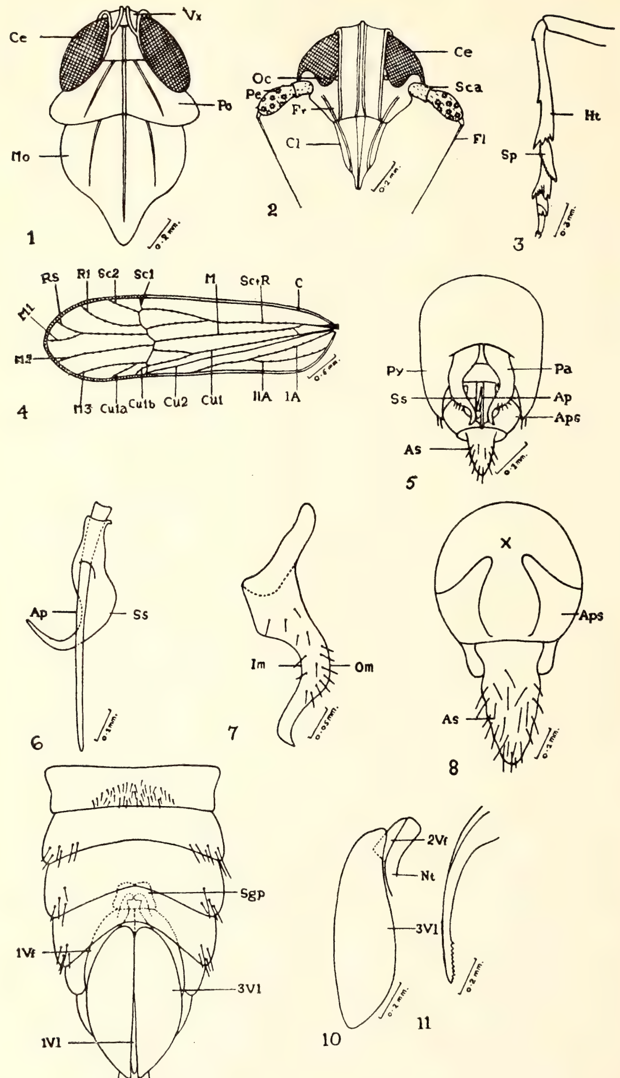
[1] Communicated by the Principal, Lohia College, Churu, Rajasthan.



Stenocranus ajmerensis sp. nov.
(For explanations see foot of p. 462)

Spur foliaceous with a few teeth.

Scape longer than half the length of pedicel.

Vertex longer than broad.

Median carina of frons double throughout its course, basally closer; vertex, pronotum and mesonotum tricarinate; the lateral carinae of pronotum diverging posteriorly and not touching the hind margin while the median carina disappears a little in front of the hind border.

Pygofer with a basal constriction, the opening as broad as long, anal angles short, rather rounded and reach up to the base of the tenth segment; diaphragm without armature; aedeagus periandrum tubular, narrowing gradually from the base to the tip; from the aedeagus basal strut arises a sickle-shaped structure with a swollen, cylindrical base which has a hole through which the aedeagus periandrum projects out; parameres hollow, basally swollen and sickle-shaped with the distal end directed dorso-laterally; tenth and eleventh segments large, anal processes short, wide, blunt and directed posteroventrally.

FEMALE

Length 5 mm. (approximate).

Agrees more or less very well with the male, but lightly coloured.

Ovipositor extends well beyond the ninth abdominal segment; subgenital plate large; basally the ovipositor roofed over by the posteriorly projecting sixth abdominal sternum; first valvifer basally hook-shaped; serrations of the second valvulae restricted to the distal region, the ventral margins also serrated distally with minute projections; third valvulae highly developed and cover to a greater extent the seventh sternum, most of the eighth sternum, and completely the ventral region of ninth tergum.

The specimens of both the sexes are more or less uniformly coloured as the types, but the ochraceous coloration of the thorax may in some cases be suffused with castaneous markings.

The number of teeth on the spur of this species vary from 12 to 15.

This species was collected for the first time by the author from Ajmer in August 1959. It has been noted subsequently in large numbers in the collections made by Dr. M. G. Ramdas Menon of the Division of Entomology at the Indian Agricultural Research Institute and the types have been selected from this material.

Stenocranus ajmerensis sp. nov. differs from all the other species of the genus so far recorded in having the median carinae double along the entire length of frons. As it tallies in all other respects

with the other species of *Stenocranus*[1], the author does not venture to place this in any different genus.

Holotype. Male, gummed on card tag bearing the data: 'inside lamp dome, Delhi, Indian Agricultural Research Institute, R. Menon Collection, June-July, 1958'. Deposited in the National Pusa Collection, Reg. No. Dn/3/62, in the Indian Agricultural Research Institute, New Delhi.

Allotype. Female, gummed on card tag bearing the same data as the holotype, but collected in September, 1958. Deposited in National Pusa Collection.

Paratypes. 1 male and 1 female collected at Ajmer by the author and 4 females bearing the same data as the types and all gummed on card tags. Deposited in National Pusa Collection. Five males and seven females in the personal collection.

Acknowledgements

The author expresses his deep gratitude to Dr. P. N. Mathur, Professor of Zoology, Government College, Ajmer, for going through the manuscript, to Mr. R. G. Fennah, Assistant Director, Commonwealth Institute of Entomology, London, for confirming the identification, and to Dr. M. G. Ramdas Menon, Systematist, Indian Agricultural Research Institute, New Delhi, for supplying specimens. Thanks are also due to Dr. B. V. Ratnam, Principal, Lohia College, Churu, for the research facilities enjoyed by me in the department.

Department of Zoology,
Lohia College, A. N. T. JOSEPH
Churu, Rajasthan,
November 29, 1963.

[1] Fieber (1866): *Verh. Zool. Bot. Ges. Wien.* **16** : 519.

Explanation to Plate facing p. 461

Stenocranus ajmerensis sp. nov.

1. Dorsal view of head, pronotum and mesonotum ; 2. Cephalic view of head ; 3. Distal region of hindleg ; 4. Tegmen ; 5. Ventral view of pygofer ; 6. Aedeagus periandrum ; 7. Ventral view of paramere ; 8. Ventral view of tenth and eleventh male abdominal segments ; 9. Ventral view of female abdomen ; 10. Lateral view of third valvula ; 11. Ventral view of second valvulae.

IA. first anal; IIA. second anal; Ap. aedeagus periandrum; Aps. Anal process ; As. anal style ; C. costa ; Ce. compound eye ; Cl. clypeus ; Cu1. cubitus one ; Cu1a. first branch of cubitus one ; Culb: second branch of cubitus one ; Cu2 cubitus two ; Fl. flagellum ; Fr. frons; Ht. tibia; Im. inner margin of paramere ; M. media ; M1. first branch of media ; M2. second branch of media ; M3. third branch of media ; Mo. mesonotum ; Nt. ninth tergum ; Oc. ocellus ; Om. outer margin of paramere ; Pa. paramere ; Pe. pedicel ; Po. pronotum ; Py. pygofer ; Rl. radial one ; Rs. radial sector ; Sca. scape ; Scl. first branch of subcosta ; Sc2. second branch of subcosta ; Sc+R. subcosta plus radius ; Sgp. subgenital plate ; Sp. spur ; Ss. sickle-shaped structure arising from the aedeagus basal strut; 1Vf. first valvifer; 2Vf. second valvifer; 1Vl. first valvula ; 2Vl. second valvula : 3Vl. third valvula ; Vx. vertex ; X. tenth abdominal segment

16. *PROPORCELLIO QUADRISERIATUS* VERHOEFF : AN ADDITION TO THE INDIAN FAUNA LIST

Proporcellio quadriseriatus Verhoeff is an isopod crustacean described by Verhoeff (1917). This species is a native of the east Mediterranean region: European Turkey (Bebek, near Istanbul), Lebanon, Israel, Libya (Cyrenaica). But it seems to be capable of transportation by man, and of surviving, at least for some time, in other parts of the world. Specimens of this species collected from Pontaillac, near Royan in the west of France, are present in the Adrien Dollfus Collection (Muséum d'Histoire Naturelle, Paris). This species has also been found in abundance in the greenhouses of the Southern Methodist University, Dallas, Texas (Geiser 1933, Arcangeli 1934, Van Name 1936).

It was first found in Bhubaneswar in great numbers under some straw on an exposed terrace in the Orissa Veterinary College. This straw had obviously been dumped some time previously as it had generated enough humus to support a few small angiosperms. The isopod species has subsequently been found in three other localities in urban Bhubaneswar both several kilometres distant from the first and from each other, and also exposed to the weather. All colonies were found during the rainy season. Adults were not found in the Orissa Veterinary College locality in December but reappeared in July 1964. This is the first record of this species in India. No doubt, it has been transported into India by man and, judging from the fact that it has been found in four different places in Bhubaneswar, it cannot be a very recent importation.

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GENETICS AND BIOMETRY LABORATORY,
GOVERNMENT OF ORISSA,
BHUBANESWAR 3,
ORISSA, INDIA, S. D. JAYAKAR
August 10, 1964.

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17. SUPPLEMENTARY NOTE ON 'THE BUTTERFLIES OF SOUTH GUJARAT'

In *J. Bombay nat. Hist. Soc.* [Vol. **60** (3) : 585-99] the writer reported 145 species of butterflies (plus seven additional female forms) for an area called South Gujarat, comprising the Dangs, Broach, and Surat districts. During the past year, five more species have been collected in this area, as follows.

SATYRIDAE

1. **Mycalesis visala visala** Moore : The Longbrand Bushbrown

   Fairly common throughout the year.

   (South India, Pachmarhi, Bengal, Simla Hills to Assam and Burma.)[1]

LYCAENIDAE

2. **Nacaduba dubiosa indica** Evans: The Tialless Lineblue

   Uncommon throughout the year.

3. **Rapala schistacea** Moore : The Slate Flash

   Sole specimen was netted on *Poinsettia* blossoms on 15 December 1963 at Ahwa in the Dangs.

HESPERIIDAE

4. **Coladenia indrani** Moore : The Tricolour Pied Flat

   Uncommon during the south-west monsoon in the Surat Dangs.

   (Ceylon, S. India to Bengal, and Mussoorie to Sikkim, and Burma.)

5. **Sarangesa purendra** (Moore) : The Spotted Small Flat

   Uncommon throughout the year in the Surat Dangs.

Not only have the above five species been added to the list of butterflies of South Gujarat, but some additional data have been recorded for twenty-one more species which were formerly reported, as follows.

SATYRIDAE

1. **Mycalesis mineus polydecta** Cramer

   Formerly reported from July to October. Now found throughout the year.

[1] As in the original paper, I have quoted Wynter-Blyth in parenthesis where my records appear to add to the range of the species.

2. **Ypthima baldus** Fabricius
   Formerly reported from July to January. Now found throughout the year.

3. **Lethe rohria nilgiriensis** Guerin
   Formerly reported from October to January. Add February and March.

NYMPHALIDAE

4. **Neptis columella** Cramer
   Formerly reported from February to April. Now found from November to May.

5. **Neptis jumbah** Moore
   Formerly reported for March. Add January and February.

LYCAENIDAE

6. **Spalgis epius** (Westwood)
   Formerly reported for July and August. Add September to March.

7. **Syntarucus plinius** (Fabricius)
   Formerly reported from November to July. Add October.

8. **Azanus jesous gamra** (Lederer)
   Formerly reported for November. Add March.

9. **Neopithecops zalmora** (Butler)
   Formerly reported for November and December. Add October.

10. **Lycaenopsis albidisca** Moore
    Formerly reported for November, December, and January. Add October.

11. **Zizeeria otis** Fabricius
    Formerly reported from October to April. Add September.

12. **Lycaenesthes lycaenina** Felder
    Formerly reported from March to May. Add October.

13. **Zesius chrysomallus** Hubner
    Formerly reported for March. Add October.

14. **Amblypodia amantes amantes** Hewitson

Formerly reported from September to March. Add April.

15. **Surendra quercetorum** Moore

Formerly reported for August and September. Add February.

16. **Tajuria cippus cippus** (Fabricius)

Formerly reported from March to November. Add July.

17. **Rathinda amor** (Fabricius)

Formerly reported from September to November. Add March.

18. **Rapala melampus** Cramer

Formerly reported from November to April. Add October.

Hesperiidae

19. **Celaenorrhinus ambareesa** (Moore)

Formerly reported from February to May. Add September and October.

20. **Saustus gremius** (Fabricius)

Formerly reported for September and October at Waghai. Add November and include the whole Dangs District.

21. **Telicota ancilla** = **Astychus augias** (Linnaeus) and **A. pythias** (Mabille)

Formerly reported from November to May. Add October.

With the addition of five more species to the area referred to as South Gujarat, there are now 150 species and seven additional female forms in this area.

The writer expresses sincere thanks to Mr. N. T. Nadkerny, Entomologist of the Bombay Natural History Society, for confirmation of the five species herewith added to the list of the Butterflies of South Gujarat.

Church of the Brethren Mission,
Ahwa, via Billimora,
Dangs District,
May 15, 1964.

E. M. SHULL

18. STUDIES ON PLANT-PARASITIC NEMATODES OF KERALA. III. AN ADDITIONAL LIST OF PLANTS ATTACKED BY ROOT-KNOT NEMATODE, *MELOIDOGYNE* SP. (TYLENCHOIDEA : HETERODERIDAE)

Root-knot nematodes belonging to the genus *Meloidogyne* Goeldi, 1892, are of considerable agricultural importance. Following Thorne (1961), Nadakal (1963, 1964) and Nadakal & Ninan Thomas (1964) have called attention to the fact that there is an increasing need for the study of the distribution of *Meloidogyne* spp. in India with respect to their host plants. Although Rangaswami *et al.* (1960, 1961) and Nirula & Kumar (1963), among others, have contributed to our knowledge of the host plants of root-knot nematodes, a great deal of information still remains to be made available. This is the third report in the series of a survey of plants parasitized by these nematodes. Plants were collected from cultivated lands in the vicinity of Mar Ivanios College, Trivandrum, during the period extending from September to December 1963. Only one species *M. incognita* (Kofoid & White 1919) was encountered and the infection was found restricted to the root-systems. The results of the present study are summarized in the following table.

TABLE

HOST PLANTS OF *Meloidogyne incognita* IN KERALA

Host plant	*Egg out-put*	*Male*	*Nature of attack*
Achyranthes aspera L.	Egg-mass not observed	..	Very mild infection and galling
Allmania nodiflora Wight	Low	..	Heavy infection and galling
Alternanthera sessilis Forsk.	Medium	Present	Heavy infection and galling ; females invade stele
Amaranthus viridis L.	Medium	..	Mild infection and galling
Andrographis echioides Nees	High	..	Heavy infection and galling
Aneilema nudiflorum R. Br.	Medium	..	do.
Borreria ocymoides DC.	Low	..	Mild infection and galling on rootlets
Canna indica L.	Medium	..	do.
Carica papaya L.	Low	..	Mild infection and galling
Cardiospermum halicacabum L.	Medium	..	Heavy infection and galling
Celosia cristata L.	do.	..	do.
Clitoria ternatea L.	do.	..	Mild infection and galling
Coleus malabaricus Benth.	do.	Present	Heavy infection and galling
Commelina benghalensis L.	One adult ♀ recovered	..	..

Cucumis sativus L.	Medium	..	Mild infection and galling
Curculigo orchioides Gaertn.	Egg-mass not observed	..	do.
Desmodium gyrans Wight	A few larvae recovered	..	..
Emilia sonchifolia DC.	Egg-mass not observed	..	Mild infection and galling
Euphorbia pulcherrima Willd.	Low	..	do.
Heliconia metallica L.	Medium	..	Heavy infection and galling on rootlets
Hedyotis corymbosa Willd.	High	Present	Very heavy infection and galling
Jussiaea suffruticosa L.	Egg-mass not observed	..	Mild infection and galling
Leucas aspera Spreng.	High	Present	Heavy infection and diffused galling
Merremia tridentata Roth	Medium	..	Mild infection and no galling
Mollugo disticha Seringe.	Egg-mass not observed	..	Mild infection and galling
Phaseolus mungo L. var. *radiatus*	Medium	..	do.
Physalis minima L.	do.	..	do.
Piper nigrum L.	High	..	Heavy infection and diffused galling
Portulaca oleracea L.	Egg-mass not observed	..	Mild infection and galling on rootlets
Solanum indicum L.	Low	..	Mild infection and galling
Spermacoce stricta L.	High	..	Heavy infection and galling
Stachytarpheta indica Vahl	Medium	..	Mild infection and galling
Struchium sparganophorum	do.	..	do.

The table serves to indicate the differential susceptibility of host plants, the rarity of males among these nematodes, and the variations in their egg out-put. *Hedyotis corymbosa, Leucas aspera, Piper nigrum,* and *Spermacoce stricta* are some of the most susceptible plants observed. By contrast *Desmodium gyrans* and *Achyranthes aspera* appear to be somewhat resistant. The weeds such as *Leucas, Spermacoce,* and *Allmania* may serve as potential 'reservoir hosts', as they grow wild on almost all cultivable lands. As Thorne (1961) has pointed out, the value of crop-rotation, which is a time-honoured method of controlling root-knot, cyst-forming, and other destructive nematodes, may be largely nullified unless the weed hosts are eliminated. Therefore, a knowledge of the weeds potentially susceptible to these nematodes would be very useful in agricultural practice. The damage that may be caused by root-knot nematodes to the economically important plant, *Piper nigrum,* remains to be assessed. To the present author's knowledge most of the plants listed have not been recorded before as hosts of *Meloidogyne* spp.

Thanks are due to the Council of Scientific and Industrial Research, New Delhi, for financial help, to the authorities of Mar Ivanios College for providing space and facilities, to Prof. A. P. Mathew for his interest in this work, and Messrs V. V. Joseph and K. P. Ravindran Nair for identifying the host plants.

DEPARTMENT OF ZOOLOGY,
MAR IVANIOS COLLEGE,
TRIVANDRUM, KERALA,
February 16, 1964.

A. M. NADAKAL

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19. *MIMOSA INVISA* MART.: A NEW RECORD FOR INDIA

(*With a plate*)

During a visit to Perunna, Changanacherry, Kerala State, in December 1963, the author collected a plant of the genus *Mimosa* which could not be compared with any of the species described in Indian floras. On investigation it turned out to be *Mimosa invisa* Mart., which has been confirmed by Dr. S. K. Mukerjee, Keeper, Central National Herbarium, Calcutta.

The taxon is a native of Tropical America. It appears that no collection of the species has so far been made from India. In Perunna it grows luxuriantly over large areas, being common on field borders and waste places, trailing or rambling over bushes. Sometimes it was observed to climb over large shrubs and small trees.

While it is possible that the plant may have been introduced there in the past, there is no evidence to confirm this from local

sources[1]. The local people say that the plant appeared suddenly in 1958 during the rainy season and established itself rapidly in several localities.

It is a very striking plant and to facilitate its identification a detailed description of the taxon with a key to the Indian species of *Mimosa* is given below. The specimens *N. C. Nair* 29745 *a-c* are deposited in the Herbarium of Botanical Survey of India, Northern Circle, Dehra Dun, and specimen *N. C. Nair* 29745 *d* is preserved in the Herbarium of Botanical Survey of India, Southern Circle, Coimbatore.

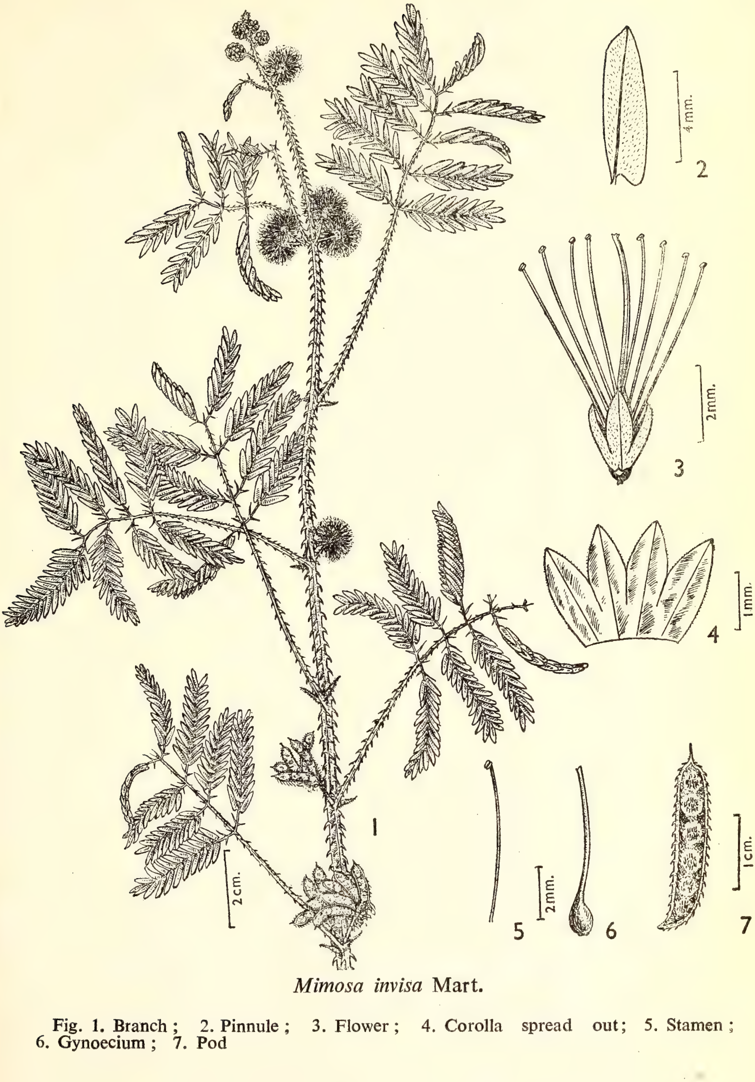
Mimosa invisa Mart. in Flora **20**; Biebl. **2** : 121, 1837; Benth. in Fl. Braz. **15** (2) : 379, t. 97, 1876 and Trans. Linn. Soc. **30** : 436 1875; Fawcett et Rendle Fl. Jam. **4** : 135, 1920; Standley in Contrib. U. S. Nat. Herb. **23** (2) : 363, 1922; Macbride, Fl. Peru 89, 1943. *Schrankia brachycarpa* Benth. in Hook. J. Bot. **2** : 130, 1840. *Mimosa diplotricha* Wright in Sauv. Pl. Cub. 34, 1868.

A shrub or undershrub with many long trailing or climbing branches. Stem pubescent-hirsute, angled, armed with downwardly pointed prickles with broad bases. Leaves alternate, 5-14 cm. long, paripinnate; rachis pilose-hirsute, prickly. Stipules setaceous, caducous. Petiole 5-9 cm. long. Pinnae 5-6 (4-8) pairs with a bristle between the pinnae, 2.5-5 cm. long; petiolule 2-3 mm. long; stipels adnate to the petiolule, pubescent, setaceous, seta unequal, longest up to 3 mm., shortest down to 1.5 mm. Pinnules 18-20 pairs, 4-5 mm. long, 1 mm. broad, oblong, base unequal, apex rounded very shortly acute, pilose beneath. Inflorescence solitary or in axillary pairs, globose, pink, much shorter than the petiole 1.5 cm. long, 11-12 mm. in diameter in the opened state of the flowers; peduncle up to 1 cm. clothed with very short prickles. Calyx minute up to 0.3 mm. long. Corolla up to 2 mm. long; petals 4 united at the base. Stamens 8, 4-5 mm. long. Pod sub-falcate, 4- 5-jointed and seeded, up to 2.3 cm. long and 4-6 mm. broad, margins spiny, valves pubescent, bristly in the centre of the segments.

Key to the species of *Mimosa* in India

Pods without stout prickles or bristles
- Pods sessile or sub-sessile ; leaves with 5-6 pairs of pinnae .. *M. rubicaulis*
- Pods long-stalked ; leaves with 6-8 pairs of pinnae .. *M. angustisiliqua*

[1] After this note went to the press, Dr. S. K. Mukerjee drew my attention to a reference (*Annual Report, Research Department, Coffee Board, India, Bangalore*, 1954-55, p. 47) that *Mimosa invisa* Mart. has been introduced into some of the coffee estates in south India.—N.C.N.



Mimosa invisa Mart.

Fig. 1. Branch ; 2. Pinnule ; 3. Flower ; 4. Corolla spread out ; 5. Stamen ; 6. Gynoecium ; 7. Pod

Pods armed with prickles or bristles		
Pinnae digitate, 1-2 pairs ; stamens as many as the petals	..	*M. pudica*
Pinnae pinnate, more than 2 pairs ; stamens twice as many as the petals		
Leaves shorter than peduncle, not more than 3 cm. long	..	*M. hamata*
Leaves longer than peduncle, more than 3 cm. long		
Pinnae 3-5 pairs ; pinnules 4-5 pairs	..	*M. polyancistra*
Pinnae more than 5 pairs ; pinnules more than 5 pairs		
Pods 6-8-seeded ; pinnules 7-8 pairs	..	*M. prainiana*
Pods 4-5-seeded ; pinnules 18-20 pairs	..	*M. invisa*

The author expresses his thanks to Dr. S. K. Mukerjee, for comparing the specimen with those in the Central National Herbarium.

BOTANICAL SURVEY OF INDIA,
63, RAJPUR ROAD,
DEHRA DUN,
May 21, 1964.

N. C. NAIR

20. *AEGINETIA INDICA* L. VAR. *ALBA* SANTAPAU : A NEW RECORD FOR NORTHERN INDIA

(*With a photograph*)

The white-flowered variety of *Aeginetia indica* L. is very rare in India and hitherto has been reported only from Khandala near Bombay, at 'a spot from which the typical species is altogether absent' [Santapau, H., 1948, *Kew Bull.* (3) : 491].

The typical species *A. indica* with normal purple-violet flowers is very common in the undergrowth in the forests around Dehra Dun, but in one small area in the *chir* pine (*Pinus roxburghii*) plantation at New Forest a solitary plant of *Aeginetia indica* L. var. *alba* Santapau was seen growing amidst the typical species *A. indica* L. where the latter is very common. This variety differs from the typical species in that the corolla is pure white and slightly longer than in the purple-flowered plants, as also the calyx and the scape which are of lemon-yellow colour.

The plant was not collected but its occurrence was recorded by

15

a photograph. As soon as the plant shows signs of multiplication,

Aeginetia indica L. var. *alba* Santapau growing together with the typical species

herbarium specimens will be collected for record.

NEW FOREST,
DEHRA DUN,
December 3, 1963.

K. M. VAID

21. AN INTERESTING ROOT-PARASITE FROM SAURASHTRA : *CISTANCHE TUBULOSA* WT.

(*With a photograph*)

In July 1962, Mr. Humayun Abdulali visited Pirotan Island in the Gulf of Cutch mainly for ornithological investigation (see *Journal* **59** : 655-658). While there, he found some curious plants with bright yellow flowers below the stems of *Salvadora persica* L., beyond the

tide mark on the edge of mangroves. The local people knew it well as 'Bamblai'.

Cistanche tubulosa Wt.
Growing in *Salvadora persica* L. above water-line
(*Photo* : *P. B. Shekar*)

A specimen was sent to me for identification and it was found to be the Orobanchoid root-parasite *Cistanche tubulosa* Wt. Both Cooke (FLORA BOM. PRES., 1961, Vol. II, p. 386) and J. Indraji Thakar (PLANTS OF CUTCH, 1926, pp. 200-202) describe its stem as being 1 to 2 inches in diameter, while the specimen referred to me measured over 3 inches. Thakar reporting it from Cutch mentioned *Salvadora persica* and also *Calotropis gigantea* and the spineless Cactus (*Nopalia*?) as its hosts. The plant is described very well by him in Gujarati (loc. cit.), and among its local uses he mentions: (1) increasing lactation in buffaloes, (2) cure against scorpion and snake bite, and (3) the application of freshly cut rhizomes, producing a sticky juice and with an odour resembling that of iodine, as a cure for wounds which refuse to heal.

BOTANY DEPARTMENT,
ST. XAVIER'S COLLEGE,
BOMBAY 1,
May 21, 1964.

P. V. BOLE

22. A SEDGE NEW TO BOMBAY[1]

(*With a plate*)

An intensive study on the flora of Bombay has been revealing many plants that, though not new to science, have never previously been recorded for the Maharashtra and Gujarat States (former Bombay Presidency). Below is presented one such plant, with the hope that the description and illustration will be of help to other botanists of Maharashtra and of Bombay in particular.

Echinolytrum dipsaceum (Rottb.) Desv. in J. Bot. **1** : 21, t. 1, 1808; Hook. *f.* in Trim. Handb. Fl. Ceylon **5** : 65, 1900; E.-G. Camus in Lecomte, Fl. Gén. Indo-Chine **7** : 130, 1912.

Scirpus dipsaceus Rottb. Descr. et Ic. 56, t. 12, fig. 1, 1773.

Fimbristylis dipsacea Benth. & Hook. *f. ex* C. B. Clarke in Hook. *f.* Fl. Brit. India **6** : 635, 1893, et Illustr. Cyp. t. 41, fig. 4-7, 1909.

This plant belongs to the Cyperaceae and is remarkable for the large marginal knobs on its fruits. The species is distributed in tropical Africa and Asia. In the FLORA OF BRITISH INDIA it is recorded thus: 'Central India, Bengal, Assam, to Burma and Ceylon'. Subsequently it has been recorded from S. Kanara, Mysore, Carnatic, Quilon, Bihar, and now from Bombay. Though it has been included under the genus *Fimbristylis* Vahl in the FLORA OF BRITISH INDIA following Bentham & Hooker in GENERA PLANTARUM (3 : 1049), 'it is not closely allied to any other species'. The species is herein included under a separate monotypic genus. The appearance of its green spikelets with their loose aristate, squarrose, persistent glumes, and the characters of the fruit are wholly different from any of the Bombay sedges, as is evident from the illustration and the description given below.

A caespitose *annual*, forming rosettes of about 8 cm. across. *Leaves* 2 on each scape, capillary, glabrous, recurved; sheath up to 1 cm. long, glabrous except for the sparsely ciliate mouth. *Inflorescence* of corymbs of usually 3-5, often up to 8 spikelets, rarely the corymb reduced to a single spikelet. *Spikelets* oblong-ovoid, obtuse, aristate, green, bracteolate, 200- or more-flowered, $4\text{-}7 \times 3\text{-}4$ mm.; bracts 2 or more in number, leaf-like, up to 1-5 cm. long;

[1] Communicated by Dr. Baini Prashad, 10 Dhobalwala Road, Dehra Dun.

Echinolytrum dipsaceum (Rottb.) Desv.

A. Habit ; B. Inflorescence ; C. Glume ; and D. Fruit

pedicel 1 cm. long, spreading or recurved, bracteole glume-like but larger; rachilla cylindrical, devoid of pits or nearly so. *Glumes* linear-lanceolate, aristate, 1-nerved, 2×0.4 mm., membranous towards the margins; arista slightly curved, green, acute, 0.8 mm. long. *Stamen* 1, lateral. *Ovary* glabrous, style swollen at the base, bifid above. *Nut* linear-oblong, curved or not, 0.8×0.2 mm., trabeculate, brown, ornamented with white capitate glands arranged in lateral, vertical, two opposite rows.

Flowers and Fruits. May to June.

Occurrence in Bombay. National Park, Borivli. It is very rare but has been found growing abundantly on moist sandy river bank temporarily exposed in summer. It occurs in association with *Cyperus pygmaeus* Rottb. and *Fimbristylis aestivalis* Vahl, forming green matting over the white sand.

Herbarium specimens examined. Dahisar River between the Dam and Bridge near the garden, National Park, Borivli (*R. R. Fernandez* 1207 and 1207 A-C, 1 May, 1953; 1767-68, 13 April, 1954, and 1790, 10 June, 1954). These specimens are deposited in Blatter Herbarium, Bombay.

MINOR FOREST PRODUCTS BRANCH,
FOREST RESEARCH INSTITUTE,
P.O. NEW FOREST,
DEHRA DUN, U.P.,
February 1, 1964.

R. R. FERNANDEZ, Ph.D.

23. CHLOROCOCCALES FROM KODAIKANAL, SOUTH INDIA

(*With a plate*)

ABSTRACT

In an attempt to list the algae from Kodaikanal, many interesting forms of Chlorococcales were discovered. The number of species recorded are 17 from among 8 genera.

INTRODUCTION

The number of papers dealing with the systematic account of the Chlorococcales have been very few. During an investigation on the algae from Kodaikanal, collected in 1954, quite a number of interesting forms were found.

Kodaikanal is a hill station in south India with an elevation of 7000-8000 ft. m.s.l. Most of the forms described in this paper are planktonic and collected from the Kodaikanal lake and a few at other places. The material was preserved in 4% formalin.

On the whole 17 species are recorded in this paper representing 8 genera.

Systematic Account

Scenedesmus Meyen 1829

1. **S. armatus** (Chod.) G. M. Smith. Prescott 276, t. 62, ff. 13, 14. (Fig. 1)

Plant of four cells arranged in a single series, fusiform-elliptic, terminal cells with a single long curved spine at each pole, central cells with a median incomplete ridge ; cells 5-7μ in diameter, 15-17μ long.

Habitat : Planktonic, Kodaikanal lake.

Differs from the type in having complete longitudinal ridges in the central cells.

2. **S. denticulatus** Lagerheim. Prescott 277, t. 63. ff. 10, 11. (Fig. 2)

Colony of four ellipsoid to fusiform cells arranged in a single series ; apices of cells with 1-3 short teeth, free walls of cells smooth ; cell 3-4μ broad, 15-17μ long.

Habitat : Planktonic, Piller rocks, Kodaikanal.

This form agrees in dimensions with *S. brasiliensis* Bohlin (Prescott 277, t. 63, ff. 5, 6) but differs from it in having a smooth cell wall, in which respect it agrees with the type, but differs from it in the shape of cells and also in dimensions.

3. **S. armatus** (Chod.) G. M. Smith. (Fig. 3)

Plant composed of four cells arranged in partially alternating series fusiform-elliptic with poles sharply pointed, inner cells with a single lateral incomplete longitudinal ridge, terminal cells with a single small spine at each pole, cells 3-5μ in diameter, 10-12.5μ long.

Habitat : Planktonic in Kodaikanal lake.

This form differs from the type in having the complete ridge in the central cells and also in having only spines at one pole. It is likely that this form may be a new variety.

4. **S. denticulatus** var. **lunatus** W. & G. S. West. Pascher, Susswasserfl. 163, f. 214, 1915. (Fig. 4)

Colony of four ovate-ellipsoid cells arranged in a single series, apices of cells with 2-4 short teeth ; free walls of cells smooth, outer cells lunate ; cells 2-3 μ in diameter, 8-10 μ long.

Habitat : Planktonic in a Kodaikanal lake.

5. **S. perforatus** Lemm. Pascher 166, f. 230 ; Prescott 279, t. 46, ff. 24, 25. (Fig. 5)

Colony of four to eight cells, cells sub-rectangular with convex end walls and concave lateral walls thus forming biconvex intercellular spaces ; end cells of colony bearing a single long curved spine at each pole arising from the corner of the cells, the outer lateral walls of end cells slightly protruded or straight ; cells 5-7 μ in diameter, 20-23 μ long.

Habitat : Planktonic in Kodaikanal lake.

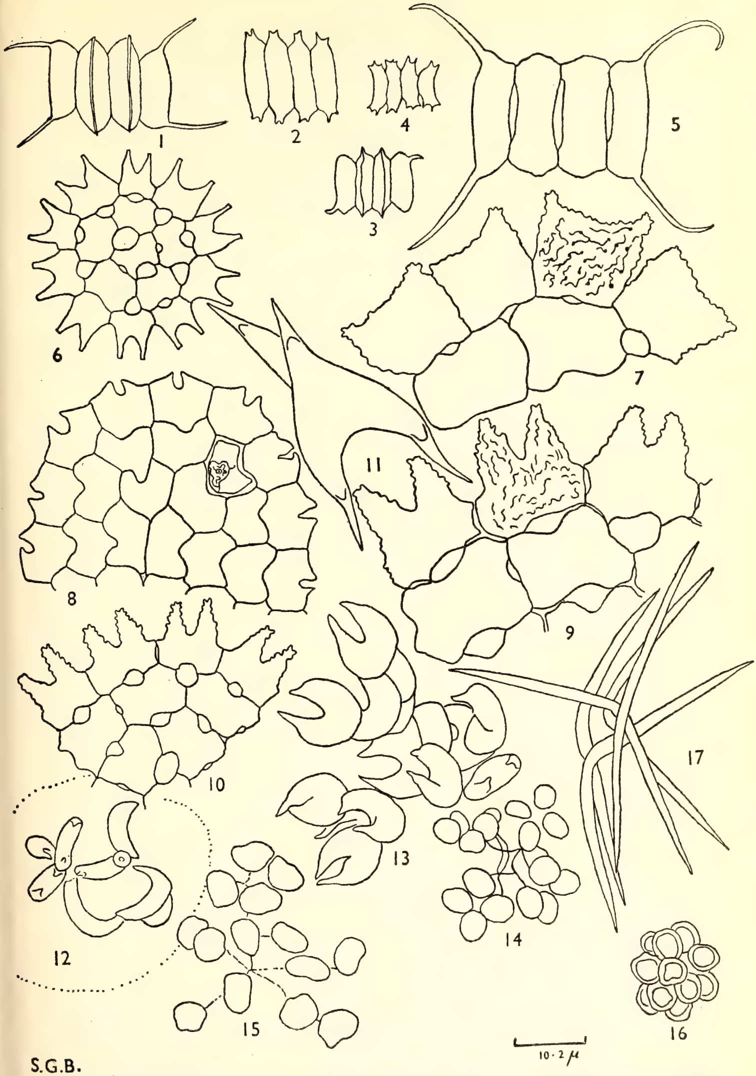


Fig. 1. *Scenedesmus armatus* (Chod.) G. M. Smith; 2. *S. denticulatus* Lager; 3. *S. armatus* (Chod.) G. M. Smith; 4. *S. denticulatus* var. *lunatus* W. & G. S. West; 5. *S. perforatus* Lemm., 6. *Pediastrum duplex* var. *clathratum* (A. Braun) Lager; 7. *P. angulosum* var. *gyrosum* Racib.; 8. *P. angulosum* (Ehren.) Menegh; 9. *P. duplex* var. *clathratum* forma *cohaerens* Pascher; 10. *P. duplex* var. *clathratum* A. Braun; 11. *Tetraëdron victorae* var. *major* G. M. Smith; 12. *Kircheneriella lunaris* var. *dianae* Bohlin; 13. *K. lunaris* (Kirch.) Moebius; 14. *Dictyosphaerium ehrenbergianum* Naeg.; 15. *Dimorphococcus lunatus* A. Braun; 16. *Coelastrum microporum* Naeg.; 17. *Ankistrodesmus falcatus* (Corda) Ralfs

Pediastrum Meyen 1829

6. **P. duplex** var. **clathratum** (A. Braun) Lager. Pascher 95, f. 57d; Prescott 223, t. 48, f. 6.

Colony of 16 cells, the walls smooth with lens-shaped spaces between the inner cells which are quadrate, wall with deep emarginations, apices of lobes of peripheral cells truncate. Cells 7-9 μ in diameter.

Habitat: Planktonic in Kodaikanal lake.

Differs from the type in having smaller dimensions.

7. **P. angulosum** var. **gyrosum** Racib. Pascher 100, f. 60d. (Fig. 7)

Colony with interstices; cells 4-5 sided, as broad as long, peripheral cells with emarginate outer wall tapering into blunt processes. Wall netted with minute dots. Cells 17-20 μ in diameter.

Habitat: Planktonic in Kodaikanal lake.

Differs from the variety in having smaller dimensions and the dotted wall.

8. **P. angulosum** (Ehren.) Menegh. Pascher 99. (Fig. 8)

Colony oblong - entire with very few minute interstices; cells 5-6 sided; peripheral cells two-lobed; margin concave to emarginate between the lobes; shape of inner cells same as outer cells, the outer margin concave. Cells up to 11.2-13 μ in diameter, number of cells in a colony 64.

Habitat: Planktonic in Kodaikanal lake.

This form resembles to a little extent *P. araneosum* (Racib.) G. M. Smith (Prescott 22, t. 47, f. 4.) but differs from it in the shape and number of cells in the colony and the outer cells which are concave and emarginate. The wall is also smooth, the size of the cell is smaller.

9. **P. duplex** var. **clathratum** forma **cohaerens** Pascher. Pascher 97, f. 57e. (Fig. 9)

Colony 32-celled with large lens-shaped spaces between the inner cells which are quadrate; peripheral cells quadrate, the outer margin extended into two crenulate truncate processes (about 7 μ long), wall of cells wrinkled, granulate. Cells 18-20 μ in diameter; outer cells 19.8 μ long; colony up to 128 μ.

Habitat: Planktonic in Kodaikanal lake.

This form resembles *P. duplex* var. *brachylobum* A. Braun (Prescott, p. 223) but differs from it in having bigger spines and also in smaller dimensions of the cells. This form also has reticulate thickenings of wall.

10. **P. duplex** var. **clathratum** A. Braun. (Fig. 10)

This form differs from the above in having smooth central cells and also smaller dimensions and also the arms of cells are wavy. Colony of 32 cells up to 77μ, cells 9-11μ in diameter and 9-13μ long.

Habitat: Planktonic in Kodaikanal lake.

Tetraëdron Kuetzing 1847

11. **T. victorae** var. **major** G. M. Smith. Prescott 271, t. 61, ff. 28, 29.

Cells 4-angled, divided into fusiform shaped semicells by deep emarginations the two semicells bilobed and cruciately arranged, each lobe ending in a stout spine; cells 20-26μ in diameter, 39-60μ long with spines.

Habitat: Planktonic in Kodaikanal lake.

Kircheneriella Schmidle 1893

12. **K. lunaris** var. **dianae** Bohlin, Prescott 259, t. 57, f. 12. (Fig. 12)

Colony of many irregularly arranged cells in a gelatinous envelope; cells strongly lunate having the inner and the outer margins parallel, slightly tapering at the apices which is bluntly rounded, cells 4-5μ in diameter, 11-14μ long.

Habitat : Planktonic in Kodaikanal lake.

13. **K. lunaris** (Kirch.) Moebius. Prescott 258, t. 58, f. 2. (Fig. 13)

Colony of many cells arranged in groups of 4-16 in a close gelatinous envelope. Cells flat strongly curved with the ends gradually tapering to a point. Cells 10-13μ in diameter, 13-16μ long.

Habitat : Planktonic in Kodaikanal lake.

This form differs from the type in having bigger dimensions.

Dictyosphaerium Naegeli 1849

14. **D. ehrenbergianum** Naegeli. Pascher 183; Prescott 238, t. 51, ff. 3, 4. (Fig. 14)

Colony ovoid of 16 oval or elliptical cells 5-9μ long, 4-6μ broad with 1 or 2 parietal chloroplasts. Cells attached in groups of 4 at the ends of fine branched strands.

Habitat : Planktonic in Kodaikanal lake.

Dimorphococcus A. Braun 1955

15. **D. lunatus** A Braun; Pascher 185, f. 280; Prescott 252, t. 55, f. 8. (Fig. 15)

Cells in groups of 4 on the ends of branched delicate threads, inner cells ovate, outer cordate. Cells 5.8μ broad; 7-9μ long.

Habitat : Planktonic in Kodaikanal lake.

Coelastrum Naegeli in Kuetzing 1847

16. **C. microporum** Naegeli; Pascher 195, f. 309; Prescott 230, t. 53, f. 3. (Fig. 17)

Coenobium spherical, composed of 16 globose or ovoid cells with the narrow end outwardly directed; cells interconnected by very short scarcely discernible gelatinous processes leaving small intercellular spaces. Coenobium 19.8-23.1 μ in diameter.

Habitat : Planktonic in Kodaikanal lake.

Ankistrodesmus Corda 1838

17. **A. falcatus** (Corda) Ralfs; Pascher 188, f. 283; Prescott 253, t. 56, ff. 5, 6. (Fig. 17)

Cells acicular to somewhat spindle-shaped in clusters, not enclosed in a colonial sheath; cells 3-4 μ in diameter, 60.66 μ long.

Habitat : Planktonic in Kodaikanal lake.

ACKNOWLEDGEMENTS

I thank Dr. M. S. Chennaveeraiah, M.SC., Ph.D., D.SC. (Montl.) for the facilities and also for kindly going through the manuscript.

DEPARTMENT OF BOTANY,
KARNATAK UNIVERSITY,
DHARWAR,
May 27, 1963.

S. G. BHARATI

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Notes and News

Eighth General Assembly of IUCN

The 8th General Assembly of the International Union for Conservation of Nature and Natural Resources held at Nairobi, Kenya, in September 1963 was attended by two participants from India, K. S. Dharmakumarsinhji as Delegate of the Bombay Natural History Society and Shri R. P. Malaviya, Education Secretary, Indian High Cmmission, Kenya, as Observer of the Government of India. The second Delegate of the Society, Shri Humayun Abdulali, was unable to attend as the necessary foreign exchange was not sanctioned by the Indian Government. Three of the resolutions are of special interest to us in India.

Firstly. In view of the threat of the early extinction of very rare and vanishing species of wild life through illegal export, the Assembly recommended that the practical and political problems involved be studied and an International Convention on regulations of export, transit, and import be drafted and submitted for the approval of Governments. [Close collaboration between countries is necessary to prevent evasion of restrictive regulations. For instance, the Indian prohibition of the export of the neck feathers of the Grey Junglefowl is avoided by sending them through the post to the United States, where their import is not forbidden. And again, according to our information, crocodile skins are falsely described as lizard skins to evade the restriction on their export from India, and are reshipped from the receiver country to their final destination correctly described as crocodile skins.]

Secondly. Recognizing the importance of national parks and equivalent reserves for the continuation of natural evolution and the fluctuation and succession of species on a natural basis, and in the interests of ecological research, the Assembly recommended that the use of chemical controls of insects or plant life be forbidden except where the National Park Authority is satisfied, after careful ecological examination, that the pest if uncontrolled will threaten areas outside such park or reserve.

Thirdly. In view of the present fashion of using apparel made from the skins of leopards, jaguars, serval cats, cheetahs, and other spotted cats, the Assembly called on all Governments to introduce immediate control to restrict the export and import of the skins of

these animals in either processed or unprocessed forms. [Urgent action is called for in this country. The prices of panther skins having risen from Rs. 100 to Rs. 500 per skin, large numbers of skins were exported in 1963. To save our panthers export should be confined to persons who have themselves shot the animals by way of lawful sport and who ship these skins out as personal baggage. Instant action was taken by the Government of Ceylon, where by the end of December 1963 the export of leopard skins was prohibited.]

PRINTED AND PUBLISHED BY V. M. PHILIP AT THE DIOCESAN PRESS
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EDITORS: H. SANTAPAU & ZAFAR FUTEHALLY

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Journal of the Bombay Natural History Society

Vol. 61, No. 3

Editors
H. SANTAPAU, S.J., & ZAFAR FUTEHALLY

DECEMBER 1964

Rs. 15

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Contributors of scientific articles are requested to assist the editors by observing the following instructions :

1. Papers which have at the same time been offered for publication to other journals or periodicals, or have already been published elsewhere, should not be submitted.

2. The MS. should be typed (double spacing) on one side of a sheet only, and the sheets properly numbered.

3. All scientific names to be printed in italics should be underlined. Both in zoological and in botanical references only the initial letter of the genus is capitalized. The specific and subspecific names always begin with a small letter even if they refer to a person or a place, e.g. *Anthus hodgsoni hodgsoni* or *Streptopelia chinensis suratensis* or *Dimeria blatteri*.

4. Trinomials referring to subspecies should only be used where identification has been authentically established by comparison of specimens actually collected. In all other cases, or where identification is based merely on sight, binomials should be used.

5. Photographs for reproduction must be clear and show good contrast. Prints must be of a size not smaller than 8.20×5.60 cm. (No. 2 Brownie) and on glossy glazed paper.

6. Text-figures, line drawings, and maps should be in Indian ink, preferably on Bristol board.

7. References to literature should be placed at the end of the paper, alphabetically arranged under author's name, with the abridged titles of journals or periodicals underlined (italics) and titles of books *not* underlined (roman type), thus :

Banerji, M. L. (1958) : Botanical Exploration in East Nepal. *J. Bombay nat. Hist. Soc.* **55** (2) : 243-268.

Prater, S. H. (1948) : The Book of Indian Animals. Bombay.

Titles of papers should not be underlined.

8. Reference to literature in the text should be made by quoting the author's name and year of publication, thus : (Banerji 1958).

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EDITORS,
Journal of the Bombay Natural History Society

Hornbill House,
Opp. Lion Gate,
Apollo Street, Fort
Bombay 1-BR.

VOLUME 61, NO. 3—DECEMBER 1964

Date of publication : 10-6-1965

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Mangrove on Shoal Bay Creek, South Andaman

White-collared Kingfishers watched patiently while White-bellied Sea Eagles soared high overhead.

(*Photo : H. Abdulali*)

JOURNAL
OF THE
BOMBAY NATURAL HISTORY SOCIETY

1964 DECEMBER Vol. 61 No. 3

The Birds of the Andaman and Nicobar Islands

BY

HUMAYUN ABDULALI

(*With a map and two plates*)

INTRODUCTION

During the many years in which as Secretary of the Bombay Natural History Society I was closely associated with its collections, I had felt the absolute lack of ornithological material from the Andaman and Nicobar Islands, where no work has been done in the last fifty years. Having now time to spare, I thought it worth while to visit the islands and make an attempt towards filling the gap.

I had the good fortune to know Mr. A. K. Ghosh, I.C.S., Secretary, Ministry of Education (Science), who was for some time Commissioner in the Andamans. He gave me an indication of the nature of the country and of conditions there, and we decided that it would be best for me to make a preliminary visit to establish contacts and investigate possibilities and costs.

PRELIMINARY VISIT

Fr. Santapau, the Director of the Botanical Survey, agreed to send a man with me as they were interested in a more extensive survey of the area, and we decided to go out as soon as the weekly air service between Calcutta and Port Blair recommenced after the monsoon, about 15th October 1963. The recommencement was very erratic and it was only

after several false alarms, bookings, and re-bookings that at 5-30 a.m. on Friday the 8th November I found myself in Calcutta and, with Mr. Balakrishnan of the Botanical Survey, caught the 6-30 plane, reaching Port Blair at 2-30 p.m. *En route* we stopped at Rangoon. I saw at the aerodrome there a Pied Harrier (*Circus melanoleucos*) and dark-necked House Crows (*Corvus splendens insolens*). Kites (*Milvus migrans govinda*) and Swallows (*Hirundo rustica*) were common. House Sparrows (*Passer domesticus*) were nesting under the eaves of the airport building ; at least two pairs appeared to have their nests side by side—I wonder if this communal habit, which has been noted in the birds from Karachi and further westwards, exists here.

We left after a halt of about half an hour, flew over the Golden Pagoda and the Irrawaddy, and soon crossed hilly country — some heavily wooded and some denuded and eroded. White cumulus clouds appeared on all sides, above and below, with bits of blue sea and sky showing in many places.

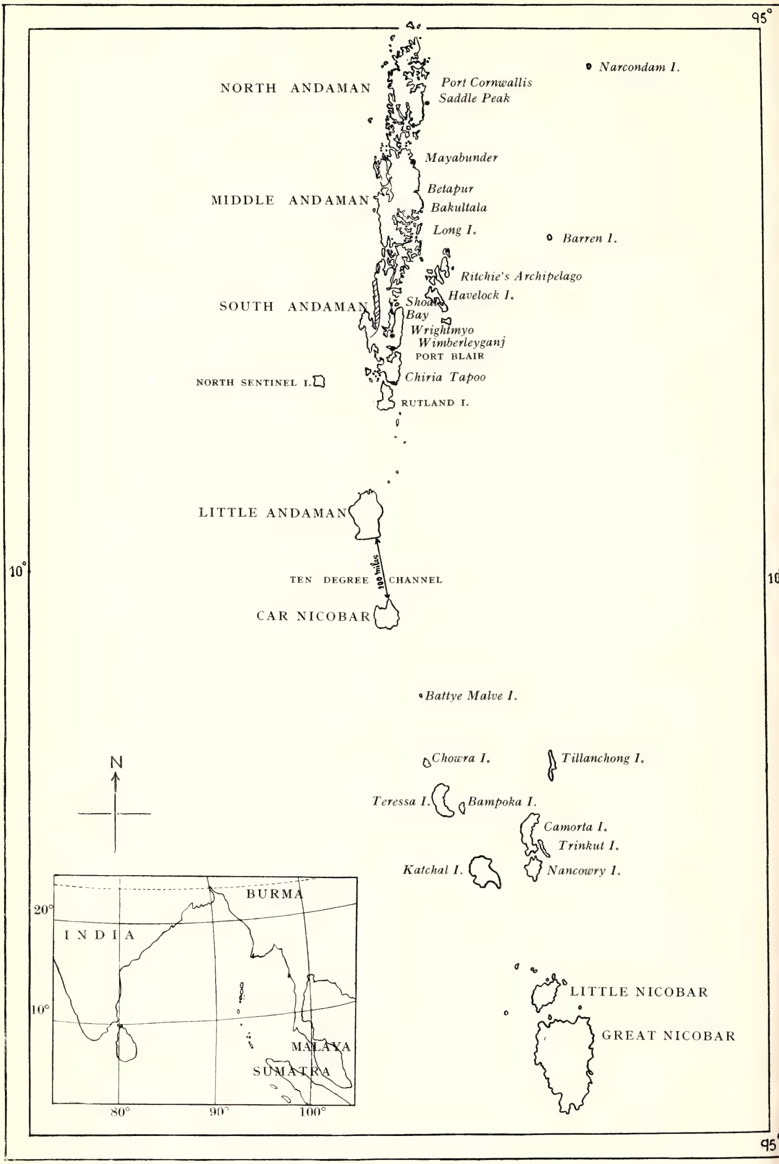
The clouds took innumerable shapes and there seemed no end to the pictures one could see in them. Some time before landing the Andamans became visible — green islands set in a sea of blue. A jeep kindly sent by the Chief Commissioner, Mr. B. N. Maheshwari, met me at the aerodrome and took me to the Guest House at Haddo, about a mile from Port Blair. The Guest House, situated on a hillock overlooking the harbour, is well furnished and is fitted with electric lights and a telephone. Before the day was over I met Mr. K. N. Chaudhri, the Chief Conservator of Forests, and Mr. J. C. Varma, the Divisional Forest Officer. I got in touch with Mr. Norman Young, who lives almost opposite the Guest House and had been mentioned to me as a keen shikari, and met a naval officer who had been out and had shot about 10 Imperial Green Pigeon (*Ducula aenea*), of which I obtained one skin.

The weather was ideal with an occasional shower — I think it rained scarcely half a dozen times during the week I was there. In the evening, frog calls in the gardens were followed up and specimens of *Rana limnocharis* and *Microhyla ornata* obtained. Both these frogs are common around Bombay, but I did not recognize their calls. In the bungalow the gecko (*Hemidactylus frenatus*) was common ; its call, a loud *chuk-chuk* uttered five times, was very similar to that of *H. leschenaulti* at Bombay, except that the *ch* part was perhaps slightly more prolonged. On Saturday morning I walked round the neighbourhood and found that deforestation had eliminated the indigenous avifauna and given a footing to introduced forms like the Common Myna (*Acridotheres tristis*), the House Sparrow (*Passer domesticus*), and the Grey Partridge (*Francolinus pondicerianus*), which were the most prominent birds at the Guest House, the calls of the last being heard from not far away.

Mangrove on narrow branch of Shoal Bay Creek, South Andaman

Frequented by the Pale Serpent Eagle. Here I got glimpses of the Ruddy Kingfisher which quivered like a dry mangrove leaf and got away before I realised my mistake.

(*Photo : H. Abdulali*)


95°
Narcondam I.
NORTH ANDAMAN
Port Cornwallis
Saddle Peak
Mayabunder
MIDDLE ANDAMAN
Betapur
Bakultala
Long I.
Barren I.
Ritchie's Archipelago
Havelock I.
SOUTH ANDAMAN
Shoal Bay
Wrightmyo
Wimberleyganj
PORT BLAIR
NORTH SENTINEL I.
Chiria Tapoo
RUTLAND I.
LITTLE ANDAMAN
10°
TEN DEGREE CHANNEL
100 miles
10°
CAR NICOBAR
Battye Malve I.
N
Chowra I.
Tillanchong I.
Teressa I.
Bampoka I.
Camorta I.
Trinkut I.
Katchal I.
Nancowry I.
BURMA
20°
INDIA
10°
MALAYA
SUMATRA
80°
90°
100°
LITTLE NICOBAR
GREAT NICOBAR
95°

Port Blair is an excellent land-locked harbour surrounded by low hills, described by Hume (1874 : 151) as magnificently wooded but now almost treeless and green only with grass and occasional shrubs and trees. The town (Aberdeen) is crowded and about 3 miles from Chatham Island, where the larger vessels berth.

This island is linked with the mainland (South Andaman Island) by a floating bridge of logs. It carries a Government saw-mill and is the headquarters of the Forest Department. Haddo, half way between Aberdeen and Chatham Island, is a suburb with two Guest Houses and the Naval Headquarters.

On Saturday afternoon I called on Mr. Maheshwari who was very cordial and offered me all necessary facilities, on payment, if my trip was sponsored by Government. He invited me to join him on the following day in a visit to Mt. Harriet, across the harbour, to inspect an experimental coffee plantation. We left by a small motor-boat, landed at Bambooflats (where Mr. Young manages a plywood factory), and motored some ten miles to Mannarghat. The climb was long and strenuous, though a path had been cleared. We returned by road, a long thirty-mile drive. The low country along the road was under paddy, the forest being restricted to the hills.

Owing to the occasional drizzle, the long straggling party, and the distraction created by leeches, very few birds were seen during the walk through the forest, but most of the parakeets, kingfishers, rollers, and bee-eaters seen in the open country were new to me, which together with the promise of all that was hidden in the forests, convinced me that a collecting trip would be worth while.

Resulting perhaps from the slight wetting and the many leech bites on Mt. Harriet, I had an attack of ague one night and woke up sweating profusely, and I felt very ill for a day ; fortunately there was no repetition and on the following day I took a taxi to Chiria Tapoo, at the southern end of South Island, intending to visit by boat some caves where Edible-nest Swifts nest. When we arrived, the fishermen had left and we could not get a boat !

I spent a week at Port Blair waiting for the return plane. Mr. Young took me to Bambooflats one day, and Mr. Sulaiman Parekh of Jadwet Trading Co. lent me a motor-boat on which I visited one or two islands and spent some time at Dundas Point on the opposite shore.

Another morning, with Mr. Maheshwari, I visited Ross Island, the administrative headquarters in the British days. Government House was a gigantic building largely of wood, now in disuse and falling to pieces. The island is largely overgrown with scrub (*Eupatorium* sp.) and we could travel only on the narrow footpath which encircled it, and on the remnants of the old roads. I picked up a dying tern (*Sterna anaethetus*) on one of the paths, and never saw another either on this or

on the main trip later. Peafowl were introduced on this island many years ago and apparently bred freely, but they disappeared during the Japanese occupation. A few more have been released recently and will no doubt establish themselves in due course. A small pond, about 60 yards across, held an empty wire cage in one corner, and I was told that an attempt had been made to introduce Spotbill Duck. No details were available, but it appeared that they had not survived for long.

I collected a few birds, and some lizards and frogs, and though I got nothing of particular interest it was evident that the area was interesting and, with the goodwill and co-operation which were available, a longer trip would be worth while.

THE MAIN TRIP

Upon my return to Bombay, I set about making arrangements for the main trip. The Bombay Natural History Society had promised me the loan of two junior assistants to look after the skinning. The Ministry of Education (Science) formally sponsored the trip and helped me to obtain the necessary shotgun ammunition from the Ordnance Factory at Kirkee, Poona.

In the meantime, the Botanical Survey had decided on an independent expedition. I arranged to sail on my own from Calcutta by M.V. *Andamans* on the 3rd February 1964. Two days before I left Bombay, one of the assistants reported ill ; I was fortunately able to obtain the services of Lawrie Nogueira from the Prince of Wales Museum, his health certificate and equipment all being arranged in a great hurry. He and P. B. Shekar of the Society joined me in Calcutta where we found the boat was not leaving on the 3rd and that the actual date would be settled in a day or two !

We sailed finally on the night of 5th February, but the morning found us still in the Hooghly anchored off some jute mills ! While we waited, parties of gulls numbering 20 to 30 hung around the ship, looking for food to be thrown overboard.

They were mostly Blackheaded Gulls (*Larus ridibundus*) with an occasional (2 out of 30) *brunnicephalus*. In addition to their larger size and the mirrors on the wing tips, the latter have a more prominently red bill. For the rest of the trip I saw no other birds, though I spent quite some time on the deck looking for them. A large turtle, a few dolphins, and many flying fish were all that I saw. The dark (blue) colour of the water suggested that this was the possible origin of the name *Kala Pani* (black water) now commonly applied to the Andamans in a derogatory sense. On the morning of the 9th we were along the western coast of the Andamans. Between North Sentinel and South Andaman I saw, several hundred yards from the boat, a large oval patch

on the water, 50 to 60 feet long and 8 to 10 feet wide. It was pale green in colour, strikingly different from the dark blue (almost black) water around it. The first impression was of a drift of algae, but through glasses I saw small yellowish oval patches, 5 to 6 inches long and 3 to 4 inches wide, 'floating' in it. It was impossible to judge what the main green effect was and how the yellow patches were fixed in it. The mass appeared to be stationary and, only after we had passed it, did I realise that I had probably seen a whale-shark basking on the surface! The boat berthed at 5 p.m. on the 9th and I was once more in the Islands.

The Andamans and Nicobars: A General Description

The Andaman and Nicobar Islands, running in a more or less north-south line between 13° 30′ N. and 6° 45′ N. in the Bay of Bengal, are separated from each other by the Ten Degree Channel. They are the summits of a submarine range of hills, 700 miles long, which connects the Arakan Yomas of Burma with Achin Head in Sumatra.

The Andamans, consisting of 204 islands, lie roughly 350 miles from Rangoon in Burma and 750 from Madras. They extend over 219 miles, the extreme breadth is 32 miles, and the whole area of land about 2500 square miles. The largest island is about 50 miles long and 16 wide; the highest point is Saddle Peak (2400 ft.) in North Andaman. All the islands, except Little Andaman, consist of hills enclosing narrow valleys, the whole covered by dense forests descending in many places to the seashore.

Though referred to in literature from the earliest times, the Andamans were in fact quite unknown till the end of the 18th century, when the East India Company in an attempt to control piracy and to prevent the ill-treatment and killing of shipwrecked and distressed mariners tried to establish a permanent settlement, an effort that was not very successful. After the Mutiny of 1857 it was decided to deport some of the many rebels and deserters on hand to the Andamans.

The original inhabitants consisted of several wild and savage tribes, anthropologically identical, short in stature and shiny black in hue. Their sooty black hair grows in small rings and, though evenly distributed over the head, appears to be in the form of tufts. They do not have the thick lips of the African negro and are said to be more closely allied to the Negritos of Malaysia. To begin with they were all hostile, especially the Jerwas and the Onges. All, except the Jerwas, have now been "tamed"; at the same time they are sadly reduced in numbers. I saw a woman at Port Blair who was one of the last seven of her tribe, and a man at Long Island (now employed by a Burmese carpenter working in the Forest Department) was one of the last dozen of his tribe. The Onges, confined to Little Andaman, have still escaped

civilization and survive in some numbers. The Jerwas, with whom there is no peaceful contact, are estimated to be between 500 and one thousand in number. They live on the western side of Middle and North Andaman and hamper the work of the Forest Department, necessitating the leaving of large areas completely untouched by Government.[1]

The Nicobars, comprising 19 islands, lie further south and show a greater variety of scenery, some of the islands being flat and coral-covered. The vegetation is less luxuriant than in the Andamans and the area is of less interest to the Forest Department. These islands have been inhabited for a longer period. Unlike the Andamanese, the inhabitants are Mongoloid.

During the current century, the Andamans have mainly been known as a penal settlement and, except for the work of the Forest Department in various parts of these two groups, there has been little development.

During the last war, the islands were seized by the Japanese and the prisoners were released to work for them. Many garbled and widely differing accounts of the occupation were heard, but I have not seen any authoritative report of this period. Contact with the Jerwas was completely broken off and, when administration was resumed after the war, Government again faced the problem of governing people who could not be spoken to or even seen.

The penal settlement has been discontinued, and the prisoners and their dependents have settled as shopkeepers and petty tradesmen. Forest labour is imported from India, mostly Orissa, and the aboriginal is scarcely visible. There is talk of settling refugees, but I cannot imagine what they will do; such attempts will only lead to the destruction of more forest, and repentance later.

Vegetation

Most of the time I was fortunate enough to be in touch with people (particularly Dr. P. M. Ganapathy) who knew the vegetation and were able to name items which were of immediate interest. These islands have been worked by the Forest Department (though I understood that no working plans existed at the moment !) and many accounts of their vegetation are available. H. G. Champion in FOREST TYPES OF INDIA AND BURMA (1936) includes 11 types from the Andamans and has some excellent photographs. Therefore, I will not lengthen this note by attempting to list the trees or describe the vegetation in greater detail.

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[1] Some interesting information about the first contacts with and impressions of the aboriginals is contained in papers by Capt. J. C. Haughton, Cols. Albert Fytche, Tytler, and S. R. Tickell in *J. Asiatic Soc. Bengal* (1861) **31** : 251, (1864) **33** : 31-35 and 162-169.

South Andamans: 10-19 February 1964

On Sunday morning, the day after my arrival, I started looking around for the transport which I had been promised. Mr. Maheshwari was away in India, and I was told that the jeep which was intended for me was in the workshop. With the help of Mr. T. N. Gill, the Development Officer, it was possible to obtain the jeep late in the afternoon with the repairs uncompleted. I took it with some misgivings, but it gave me excellent service.

I had intended to camp at Mannarghat or Wimberleyganj, but Mr. Young recommended Wrightmyo, at the end of the road, as being in wilder country and I am glad I took his advice. It was impossible for all of us, including a Forest Officer and a newly-acquired cook, to get into the jeep, so we divided the luggage, leaving some of it at the Guest House.

We reached Wrightmyo unannounced at about 9 p.m., and were soon installed in the two-room forest bungalow, about 500 feet up on a forested hill-side. The following morning I walked down to the road which passed by the bottom of the hill, and then another half-a-mile to where it ended at a small pier. A few small houses and huts along the road were occupied by farmers and fishermen of Burmese origin. The pier jutted into a small creek used by forest launches which visit Pachong and other forest depots. We were at the end of what was perhaps the longest road in the Andamans, most transport being by water.

Wrightmyo offered many different types of ecological facies. A light-railway line went past the pier about a mile into the forest, where it ended at the bottom of a gigantic chute down which timber was dropped to the railway line and then loaded on to trolleys with the help of elephants; the labour was mostly Christians from Orissa, there being no trace of any indigenous people. The hills behind the bungalow rose in series to Mt. Harriet which I had visited in November, but I did not make another attempt finding sufficient material much lower and nearer to keep me and the assistants busy.

One day I went up in the forest launch to Pachong, a forest working camp. The tidal creek (Shoal Bay) ran for many miles and the mangroves, mostly *Rhizophora mucronata* and *Bruguiera gymnorhiza*, formed dense forests of timber quite close to the water. Their roots washed by every tide were slimy with mud and it was extremely difficult to move even a few paces through this maze on foot. It took me quite some time to recover a bird which I dropped a few yards off the shore, and it was impossible to imagine how the aboriginals, as stated by Mouat, ran over the mangrove roots, presumably of this kind.

Immediately upon my arrival at Wrightmyo, a bush-policeman Balacius, armed with an ancient ·410 rifle, was attached to me for defence

against the Jerwas. At Pachong there were more such policemen and there was great consternation when I walked unattended a few hundred yards into the woods and back. My personal guard had been there for 5 years but had not seen a Jerwa, nor had any others whom I questioned at Pachong. The usual reply which we got was that you only see a Jerwa once, just before you die, when he comes to retrieve his arrow! I was told by Forest Officers that, when the places for drinking water become more restricted with the approach of the dry weather, the Jerwas (like all jungle creatures) necessarily approach the various camps which are situated near their water-holes. All this sounded unbelievable but a couple of days later, while I was driving along the road near Wrightmyo, a Forest Officer stopped me and showed me two arrows which he said had been shot at somebody at Pachong the same morning.

Many of the high trees have deep buttresses and, if a Jerwa chose to hide behind one along a forest path or near a water-hole, there would be little or no chance of his being detected—to ensure that there was no ambush, one would have to make a 20-yard circle round every tree! The trees were so high that Imperial Green Pigeon in the higher branches only peered down enquiringly when No. 6 shot was fired at them.

As I said before, many types of country were accessible. Immediately across the road at the bottom of the hill ran a line of paddy fields about 200 yards wide and half a mile long. Snipe and Golden Plover frequented the wet patches, while Bee-Eaters, Swallow-Shrikes, Rollers, and other insect-eating birds were found on the edge of the forest immediately beyond. The mangrove creeks held several kinds of kingfishers with an occasional Serpent or Whitebellied Fishing Eagle. Mr. Young arranged a pigeon shoot at Maymyo, nearer to Port Blair. The pigeons were not very co-operative, but travelling to and fro I saw many interesting types of country. Along some of the tidal creeks the high 4-foot fern *Asplenium acerifolium* formed dense patches, while the small palm *Phoenix palludosa* grew on swampy margins. The denuded uncultivated hill-sides were covered with *Eupatorium* sp. (Compositae) which takes the place of *Lantana* in India.

On this trip we arranged for a man and a boat to take me on the following morning to the Swift caves at Chiria Tapoo. After lunch at Wrightmyo I drove out to a rubber plantation near Mannarghat to collect Hawk Owls which I had heard in that area. Two were obtained without much difficulty as they called from exposed perches a little after dark. I led the way back to the car, torch in one hand and gun in the other. The bush-policeman Balacius, who followed carrying the birds, suddenly shouted '*Samp kata*' (snake has bitten). I swung round and got my torch on to a middle-sized snake disappearing into the grass, but my gun was over my left arm and I could not shoot it. Balacius was bitten just over the ankle and I was very worried. Getting

him into the jeep I drove to Wimberleyganj and burst on a group of Forest Officers at a game of cards. Not particularly perturbed, they suggested that I drive him to the hospital at Bambooflats.

I asked them to telephone the hospital that I was coming and got there in a short time. However there was no trace of the doctor, who was finally produced after much shouting. He had no anti-snake serum and merely lanced the fang-holes, giving me a long talking-to for not washing the leg immediately. I did not recognize the snake but was fairly certain that it was not one of the big five—King Cobra, Cobra, Russell's Viper, Phoorsa, and Krait. Not wishing to assume unnecessary responsibility, I left Balacius at the hospital for the night.

In the morning I picked up Balacius on my way to Chiria Tapoo, none the worse for the incident. At the appointed place we found neither man nor boat! People were few and far between and we wasted an hour or more looking for our man and investigating other means of transport. Again frustrated, we went back a few miles and stopped at a tea-stall at the edge of a forest clearing. The proprietor, a Moplah, was very curious to know what we were doing and when I mentioned the Swift caves he was very excited and said he knew a man who knew the caves and that we could walk to them. This seemed unlikely but, in the absence of an alternative, we drove back. The Moplah then disappeared for a time and returned with a man who that very morning had told us that a boat was necessary. It was now 2 o'clock and, as it is dark by 5, it looked as if the trip must wait till the morrow. However the Moplah, an elderly man, had become very interested and wished to join—he had not seen the caves himself. Rather reluctantly, we started off along a cart-track which soon disappeared into the forest, and we moved along with our guide marching rapidly ahead. In the Andaman forests one can travel more freely than in India, because there is in most places relatively little undergrowth—but it makes it very much easier to get lost. After a while we met the shore again and walked along it. The shore held many forms of sea-life but I was unable to identify many items. After about 2 hours of hard walking, which included scrambling over rocks on the shore, we reached the two caves at Mandapahar and obtained many nests of the Whitebreasted Swift and a few of the edible variety. More details of the caves, the birds, and the nests will be found under Swifts.

The way back was also a scramble as we wished to reach the car before it was too dark. We did the last mile or so in the dark but managed it without much difficulty. A rustle, which alarmed me greatly, proved to be a land crab (*Cardisoma carnifex*) only three inches across the back, but with stout pincers four inches long. The drive back to camp passed through Ferrarganj, named after Lt.-Col. M. L. Ferrar, a Life Member of the Society, who was the Chief Com-

missioner in the Andamans in the thirties. We used torches all around the car but no mammals were seen.

MIDDLE ANDAMANS: 20 FEBRUARY TO 5 MARCH 1964

Having obtained 130 birds of 62 species by the 18th, we returned to Port Blair on the 19th and caught the ferry-boat *Cholunga* on the following morning, reaching Long Island in the Middle Andamans at about 4 p.m. As our luggage was being carried to the Rest House, I met the Divisional Forest Officer, Mr. S. S. Bhattee, at his office above the jetty. He had not received my telegram and was about to leave for Bakultala towards the north. He invited us to accompany him and, transferring most of our luggage to his launch, we moved off. Mr. Bhattee, who is also a member of the Society, was very keen and helped us in many ways.

Unfortunately Bakultala was a forest depot, and the immediate surroundings did not produce many new specimens. A long trolley line ran into the forested areas and we made an interesting trip along it. At lunch one day, a message came that Jerwas had killed a man at a forest camp some miles away. As the chief administrative officer in the area, Mr. Bhattee rushed off to attend to all the formalities and returned the following morning. In the afternoon of the 23rd we moved by motor launch to Betapur. Portions of the coast were scenically enchanting. Betapur, also a forest depot, is situated beside a tidal river, which runs into the sea a few miles away. In a small dug-out we were able to cover some interesting country, on both sides of Betapur and on the opposite bank. Here I saw for the first time the Andaman Teal, whose flight was similar to that of the Whistling Teal. Green Pigeons (*Ducula aenea*) were numerous and, if so inclined, one could take a position under a fig tree in fruit and shoot an indefinite number.

A message that the Chief Conservator of Forests was arriving at Long Island on the 26th brought Mr. Bhattee, and perforce us, back to Long Island on the 25th evening. Here I was put in touch with U Thin, a Burmese carpenter in the employ of the Forest Department and a keen shikari. He and I did several trips together, on foot and by boat, reaching the far end of Long Island as well as Guitar Island to the south. But we got only a few new birds, and it was not possible to keep the skinners fully employed.

On the 29th Mr. Bhattee took us in his launch to North, Middle, and South Button Islands in Ritchie's Archipelago. The three islands are quite different from each other, and each is interesting and delightful in its own way—sandy beaches, rocky cliffs, high and low forests, and caves where Hume got nests of the Swiftlet (*Collocalia*) almost a hundred years ago. We entered the caves, but saw only one

nest. On the beach, we got our first specimens of the Crab Plover (*Dromas ardeola*), the Great Stone Plover (*Esacus magnirostris*), and Rosy (*Sterna dougalii*), Blacknaped (*Sterna sumatrana*), and Lesser Crested Terns (*Sterna bengalensis*). The beaches held shells and cowries of many hues and sizes, and everybody's pockets were soon bulging. In a small boat we paddled over a coral reef, a spearman poised at the bow to spear the large turtles—we dug up a nest with many eggs which we had for lunch. A large monitor (*Varanus salvator*) was killed and similar eggs were found in its stomach. With so much to see and do we left each island with reluctance and finally turned homewards, already belated, leaving South Button Island, apparently the most interesting, almost unexplored.

Nogueira, who had been 'borrowed' for a month, left for Port Blair to catch the first boat for Bombay or Madras. A little later, we learnt that the Deputy Commissioner's trip to the Nicobars had been cancelled because of the expected visit of Dr. Zakir Hussain, Vice-President of India and a member of our Society, to the Andamans and Nicobars. Realising that the hands of the local officials would be full for some time, I decided to return to Bombay, leaving Shekar to collect on Car Nicobar for two to three weeks.

We returned to Port Blair on the 5th March and found that the boat for Calcutta had left the previous day but I could leave for Madras the next evening—no air-bookings were available. I jumped at the opportunity of a visit to Car Nicobar.

Car Nicobar : 6 March 1964

Early morning found us on Car Nicobar with a jeep kindly provided for our use. A motor road extends along the length of the island and I drove along until we found it blocked by a fallen tree! In some of the few birds collected the racial differences from the Andaman forms were visible in the field, e.g. Imperial Green Pigeon, Whitecollared Kingfisher, and the Blacknaped Oriole.

Car Nicobar is mostly a coral island, with sandy beaches and largely planted with coconuts—there was little or no undergrowth. I discovered here how easily one can get lost. Leaving the jeep on the road I had walked a short distance to collect Imperial Green Pigeon which were obviously very different from those in the Andamans. I shot one, moved a little further to get another, and then turned back, as I thought. Suddenly I realised that I had walked in the wrong direction and there was nothing by which I could take my bearings! I tried walking 500 paces in one direction, coming back to the same place, and walking again the other way, but this did not help. Shouting

produced no response. Would letting off my two remaining rounds of ammunition be worth while? I could not have been lost for much more than half an hour, but the chance of missing the boat that evening was distressing. Fortunately, Shekar realising that I could not still be chasing pigeons had sallied forth shouting loudly and helped me home. We worked our way back to the jetty after arranging for Shekar to camp with Messrs Akoojee & Co., who have a colony on the island.

I reached Madras in the afternoon of 10th March, and travelling by the night plane arrived in Bombay the next morning.

Shekar stayed on Car Nicobar till the 13th, visiting Nancowry Island by ferry on the 14th and returning to Port Blair on the 15th. Till the 26th he worked around Port Blair, obtaining in all 49 skins. While there were not many additions to the variety of forms, the additional specimens have helped with the taxonomic work.

The object of the trip and the collection were mainly ornithological but, in view of the very scanty information which is available regarding the other vertebrates of this area, I am recording a few of my observations before dealing with the birds.

Mammals

The largest indigenous wild mammal, the Andaman pig (*Susscrofa andamanensis*), is much smaller than the Indian pig. A sow weighing 56 lb. was obtained at Bakultala, Middle Andamans. This is being mounted for the Prince of Wales Museum of Western India in Bombay. Returning by ferry from Long Island, 4 live pigs were brought on board at Havelock Island, all trussed up and ready for sale at Port Blair. A 30 kg. spring balance weighed the two sows as 24 and 26 kg. (53 and 57 lb.). We estimated the male as 30 to 40% heavier, say 80 lb.—a big boar in India weighs over 300 lb. The Jerwas hunt them on foot and the Indian labourers do the same with the assistance of dogs. The young are said to be striped as in India. In 1962 (*J. Bombay nat. Hist. Soc.* **59**: 281) I referred to the possibility of more than one species of pig occurring in the Andamans, but am unable to offer any more information in this respect.

Chital and other deer were introduced into the Andamans '25-30 years ago' [J. Banerji (1955): *J. Bombay nat. Hist. Soc.* **53**: 256], and are said to be abundant on some islands. At Port Blair, venison was quoted at Rs. 3 per kg. (though not available!) and mutton at Rs. 6. Chital skins were on sale, and I was told that 20-30 were available every month.

In a retail shop at Port Blair, I obtained a middle-sized deer skin (shot in South Andamans) of one colour and too small and dark to

be a sambar's. It has not been possible to match it with any of the skins of Indian deer available in Bombay[1].

There were reliable reports of sambar (*Cervus unicolor*) and also a small red deer, probably Barking Deer (*Muntiacus muntjak*). I was taken to Guitar Island (opposite Long Island) in pursuit of a small deer or antelope with pig-like tusks—I only got a glimpse of something that looked too dark for either Barking Deer or Fourhorned Antelope and wonder if it could have been musk-deer.

These would all be relatively recent introductions like the Chital. I was told that the Jerwas do not kill the newly introduced deer, though it is believed that they have learnt to use dogs.

The civet cat (*Paguma larvata tytleri*) has been recorded from the Andamans; I obtained one skin each from Mr. Bhattee and Mr. Young. It has been suggested that the absence of partridge, quail, and other forms of ground-living birds is due to the presence of these civets. Hume obtained reports of megapodes in the Coco Islands[2] and thought he saw their mounds. Kloss (1903 : 328, footnote) suggested that the absence of megapodes in the Andamans may be due to the introduction (?) of the civet cat (*Paradoxurus tytleri*).

One hears of panthers having been introduced to keep down the chital, but I was unable to obtain any definite information. Banerji (loc. cit.) refers to two *females* being released in 1952-53. A responsible officer told me that two had recently been brought from India for release in the Andamans but public opinion was so strongly against it that they were either destroyed or sent back. Perhaps this was a different pair.

Near Port Blair, I saw some palm squirrels (*Funambulus* sp.) apparently recently introduced, but did not note the species.

I had no arrangements for trapping any of the smaller mammals and, except for one or two glimpses of deer (?), the deer skins in the market, and some pig wallows in the forests, I saw no large mammals other than a couple of largish rodents on the road at night.

I collected 11 bats of 6 species of which, at the time of writing, only one *Cynopterus brachyotis brachysoma* Dobson (type locality,

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[1] Mr. J. E. Hill, who kindly examined the skin at the British Museum (Natural History), reports that it agrees fairly closely with the Museum's limited material of Sambar from the Malaysian Archipelago but without the skull it is difficult to be quite certain of the identification.—EDS.

[2] In Indian ornithological literature the islands, Great Coco and Little Coco, lying north of the Andamans along the 14th parallel of north latitude are frequently referred to as Cocos. The name in this form must not be confused with the Cocos atoll in the Cocos-Keeling Group, about 14° south of the Equator and 600 miles south-west of Java Head. The few birds of the Cocos atoll are mostly oceanic, and the resident birds have Malaysian affinities. Besides these islands there is an islet in the east Pacific north of the Galapagos known as Isle del Coco. The references in this paper are restricted to Great and Little Coco, irrespective of how they are spelt.—H.A.

Andamans) had been identified with certainty. It is hoped that it will be possible to report on the others in a short time.

Mr. Young's son Maxie mentioned seeing a dugong which had 'bristles as in a pig' on its head or nape. The body is known to be covered by hair-like bristles, and it is curious that J. H. Williams in THE SPOTTED DEER (1957, p. 209, Rupert Harte-Davies) says of a manatee in North Andamans: 'She had a short mane on her head, which swept back with her motion'! Blyth (1859, *J. Asiatic Soc. Bengal* **28**: 271-298) refers to bones of the dugong (*Halicore indicus*=*Dugong dugon*) being found in a native hut. Though it is now fairly rare, around 1905 it was said to enter Port Blair in parties of two and three (Annandale, *J. Asiatic Soc. Bengal*, 1905, N. S., **1**: Footnote at p. 241). The mammals obtained by Abbott & Kloss and reported on by G. S. Miller in *Proc. U.S. Nat. Mus.* (1902, **24**: 751-798) appear to form the only systematic collection made in this area, and it is possible that new forms remain to be discovered.

Miller (loc. cit.) notes that all the forms, except the dugong and the bats, could have been introduced by man, either intentionally or otherwise, and the depth of the surrounding sea (though shallow towards Burma) suggests that these islands were separated from the mainland before any mammals reached them.

Reptiles and Amphibians

We collected and pickled 9 snakes (6 species), 26 lizards (8 species). frogs and toads (7 species). Curiously, all the snakes are already represented in the collections of the Bombay Natural History Society, having been presented by that remarkably active collector Col. Wall. The lizards and amphibians are being examined and a report will be published later, if any material of interest is found.

The few insects and ticks preserved appear to be species common to India.

Birds

In 1846 Blyth listed some birds obtained in the Nicobars by Mr. Barbe and Capt. Lewis, and later (1863) appended a list of the Andaman birds to Mouat's ADVENTURES AND RESEARCHES AMONG THE ANDAMAN ISLANDERS. About the same time Tytler, Beavan, and Ball made some collections, reports on which are included in the bibliography to this paper. In 1872, that extraordinary person, Allan Octavian Hume (who was among other things 'father and founder' of the Indian National Congress !) sent his collector Davison to the islands, who collected some 2000 birds in about six months. In February 1873,

Hume accompanied by several friends (only Stolickza's name is traceable) made a one-month visit to the islands by a chartered boat from Calcutta. The procedure was to make a landing during the day, collect all that was available, and return to the boat in the evening. An interesting account of this trip (Hume 1874) is followed by a report on the collections together with references to all earlier literature on the birds of the Andamans and Nicobars. About the same time collections were made by Captains Ramsay Wardlaw and Wimberley, which were reported upon by Viscount Walden. There was considerable activity for some time, which lapsed until revived by Butler (1899, 1900), Abbott & Kloss (Richmond 1903), and Osmaston (1905-1908). Subsequent to this however, except for half a dozen notes on snipe and other sporting birds, the islands have remained ornithologically untouched. The introduction and recognition of racial, or subspecific, differences necessitated a re-examination of the original collection, but I have seen no evidence of this having been done. When in the field, I collected mainly with a view to add to the Society's collections and paid special attention to the forms which were accepted as different from those in India. While working out the collection, and comparing it with the material available in Bombay, it was soon evident that many of the specimens were different from Indian forms. This has led to the discovery of an unexpected number of new subspecies, some of which were noticed by others earlier, but were ignored by subsequent workers for unspecified reasons.

The list of birds includes several introductions which have established themselves. While these may to some extent be occupying vacant ecological niches, there can be no doubt that they intrude and trespass upon some local forms to the latter's disadvantage. The absence of a natural check is perhaps the main reason for the violence with which introduced forms sometime 'explode'. The African Land Snail (*Achatina fulica*) is an example. I was told it was brought into Port Blair some ten years ago, and has now multiplied to such an extent that gardening and vegetable growing have been rendered difficult. Its depredations in the Guest House gardens were very prominent in November. I was informed that Openbill Storks (*Anastomus oscitans*) were ordered from India to combat this menace, but it was not possible to ascertain how, assuming they eat these snails, the Storks were to be led round the gardens looking for these nocturnal creatures. It is curious how man has always been more anxious to introduce new forms to insular areas, rather than to study those which already exist there.

We obtained in all 312 specimens including 35 from Car Nicobar and Nancowry. In the following list they fall into 112 species and subspecies including four subspecies newly described (Abdulali 1964).

The Zoological Survey of India has, I understand, made three expeditions to the Andaman Islands over the last few years; I am

sorry that it was not possible to ascertain what ornithological material was obtained by them, as they are being worked out independently. My conclusions are therefore to a large extent based on the relatively little material available to me and the literature cited in the bibliography. As many of the references are old and not easily available, I have in many instances quoted the original records and given my reasons for supporting or discrediting them.

The list covers 225 forms, which number is small when compared with say approximately 400 from an equivalent area near Bombay. With further study, this number will no doubt increase but not, I think, to the same extent. Several of the birds listed, e.g. pelican and Brahminy Duck, are based on records of single individuals blown in with storms or cyclones. Bayley-deCastro (1933) refers to two vultures of unnamed species seen after a cyclone. Others are introductions by well-meaning people who failed to see and appreciate the indigenous avifauna. Except for the megapode and the Nicobar Pigeon, the avifaunal affinities appear to be closer to India than to Burma or Malaya. The resident forms in the Andamans and Nicobars, as would be expected in insular species, are often different from each other. It has not been possible to name trinomially a few of both the migrant and the resident birds, and it would perhaps be better to comment on the trends of variations after a closer study has been possible.

Acknowledgments

Before I proceed with the list, I must acknowledge with gratitude the interest shown by Mr. A. K. Ghosh, Secretary, Ministry of Education (Science), which actually encouraged me to make the trip ; the financial assistance given by the Bombay Natural History Society, the Prince of Wales Museum of Western India, and the Sir Dorabji Tata Trust ; the assistance and co-operation given by Mr. B. N. Maheshwari, Chief Commissioner, and the other officers in the Andamans, without which it would not have been possible to achieve a fraction of the work ; the willing co-operation extended by Messrs Norman Young, S. S. Bhattee, Sulaiman Parekh of Jadwet Trading Co., and other residents in the Andamans ; the ready and cheerful manner in which Lawrie Nogueira and P. B. Shekar skinned all the birds brought in, large and small, throughout the hours of daylight and even late into the night. Acknowledgments for specific items are made in the text. I must not omit to acknowledge the help received from Mr. M. J. Pereira, Bombay Natural History Society, in handling, measuring, and comparing the new specimens with those available in Bombay.

SYSTEMATIC LIST

Note. The scientific names are from Ripley's SYNOPSIS (1961) where available and his serial numbers are prefixed for convenience of reference. An asterisk on the left indicates that the bird has been seen or collected by me.

BIRDS OF THE ANDAMAN AND NICOBAR ISLANDS

[14. **Oceanites oceanicus oceanicus** (Kuhl) (South Georgia). Wilson's Storm Petrel.

Not listed from the area in the SYNOPSIS but recorded by Biswas from Andamans (1964). If this is with reference to Hume's observations between Preparis and the Cocos, repeated by Butler (1900 : 151), it is too indefinite to be accepted.]

[15. **Fregetta tropica melanogaster** (Gould) (Southern Indian Ocean) Duskyvented Storm Petrel.

Ferrar (1932) identified a storm-tossed bird as of this species, but added ' it had no white markings whatsoever barring the extreme bases of certain feathers being white '. As the bird was not preserved and this species has completely white underparts, except for a central dark line from chin to vent, there appears to have been a mistake in identification and the record is best dropped.]

17. **Phaethon aethereus indicus** Hume (Mekran Coast) Short-tailed Tropic-bird.

Hume (1874 : 323) said he was informed that this species was often seen on the passage to and from the Andamans, especially in the monsoons, and in the neighbourhood of the Cocos. He added that Davison and others saw a *Phaethon* with a white tail over two feet in length at Treis (Nicobars), which was probably of this species.

Biswas (1964) has drawn attention to the omission of the Andamans from the known range of the species in Ripley's SYNOPSIS (1961).

Incidentally, Article 27 of the International Code of Zoological Nomenclature prohibits the use of a diaeresis which is used by Ripley in the SYNOPSIS for *Phaethon* and other names.

18. **Phaethon rubricauda rubricauda** Boddaert (Mauritius) Redtailed Tropic-bird.

Blyth (1846b : 374) refers to *P. aetherus* from the Nicobars as the only tropic-bird from the Bay of Bengal, and Hume (1874 : 322) says the specimen was *rubricauda*. Listed from the Nicobars with a query in the SYNOPSIS but confirmed by Biswas (1964), though the evidence is not mentioned.

19. **Phaethon lepturus lepturus** Daudin (Mauritius) Longtailed Tropic-bird.

Tytler claimed to have shot a *Phaethon candidus* (Brisson) in the Andamans (Blyth 1863b). This was presumably the specimen examined by Hume (*Stray Feathers* **5**: 498) and referred to as *P. flavirostris*, the Yellowbilled Tropic-bird. Both these names are now synonyms of this form.

21. **Pelecanus philippensis philippensis** Gmelin (Manila) Grey or Spottedbilled Pelican.

This species is listed from the Nicobars by Blyth (1846b & 1863b). Hume (1874 : 324) states that Blyth's record was based on a specimen brought in by Capt. Lewis and says that it may well have come from Burma. Butler (1900 : 150) was informed of a pelican seen at Port Blair after a cyclone. These records are omitted from the SYNOPSIS and I wonder if it would be worth while reviving them, as Biswas (1964) has done. In any case, the absence of suitable habitats for the bird would clearly indicate that they can only occur as accidental vagrants.

[24. **Sula sula rubripes** Gould (New South Wales) Redfooted Booby.

Hume (1874 : 324) states : ' When out at sea about opposite Preparis on 4 March, and again when near the Cocos, we saw each time a pair of dusky boobies chasing flying fish ; one pair passed within a short distance of the vessel, and I am pretty confident that they belonged to this species ', i.e. *Sula fiber* Linn. The only Indian specimen known (in the British Museum) was collected in the Bay of Bengal (1929, FAUNA **6** : 289, repeated in SYNOPSIS, p. 9).]

37. **Ardea purpurea manilensis** Meyen (Philippines) Purple Heron.

Davison and Hume obtained only one specimen but reported seeing it in the Andamans and the Nicobars (Trinkut and Tillangchong). Butler says it occurs in both groups but is rather scarce everywhere. Osmaston (1906a : 491) said it was not uncommon in open swampy places. It is not mentioned in the SYNOPSIS for this area (Biswas 1964).

[**Ardea sumatrana sumatrana** Raffles (Sumatra) Dusky Grey Heron.

Abbott and Kloss (in Richmond 1903) said they had not obtained specimens but seen it on Trinkut, Katchal, and Great Nicobar. This is omitted in the SYNOPSIS, not having been recorded from anywhere else within our limits.]

*39. **Butorides striatus spodiogaster** Sharpe (Andamans & Nicobars) Little Green Heron.

1 ♂, 2 ♀♀ Betapur, M. A.

Several were seen in mangroves at Bakultala and Betapur, Middle

Andamans. In the Nicobars, Butler (1900: 153) said, they were so numerous that at low tide 20 or 30 could be counted at one time. The wings are smaller 157(♂) to 164(♀) against 167 to 171 mentioned in the FAUNA. Osmaston, Wickham, and Anderson are said to have taken many nests during May and June on various islands in mangroves 2-4, occasionally 8, feet above high tide. The eggs are smaller than in the Indian birds. A ♀ shot on 22 February had a slightly enlarged ovary.

Biswas (*Current Science* **28**: 288, 1959) pointed out that Indian birds were different from *javanicus* of Horsfield (type loc.: Western Java) being paler, with longer moustachial streaks and longer wings (18 ♂♂ 174-184 mm., 6 ♀♀ 177-182 mm., against 3 ♂♂ 165-174 and 2 ♀♀ 166-174 in Java specimens) and used Bonaparte's name *chloriceps* with Hitaura, Chisapani, Garhi Province, Nepal, as type locality.

The Bombay collection contains 17 specimens, of which 7 ♂♂ and ♀♀ from Kutch (1), Bombay (5), and Ratnagiri (1) have wings 163-168 mm., average 165·2 mm. Five of these, and another from Ambala, Punjab, (wing 171), which are in comparable plumage, are as dark as those from the Andamans, though the latter in adult plumage differ in having more grey on the wing quills. Two larger (wings 175 and 184 mm.) and paler birds from Sandoway, Burma, and Darbhanga, Bihar, are presumably *chloriceps*.

It is apparent, as has been suggested by Biswas (loc. cit.), that the races occurring in India have still to be worked out.

*42. **Ardeola grayii** (Sykes) (Dukhun) Pond Heron or Paddybird.

1 ♀ Wimberleyganj, S. A.

Said to occur in both the Andamans and Nicobars in the SYNOPSIS, but I have been unable to trace the latter record(s). Ball (1870a) admitted his record from Trinkut to be uncertain but, later (1880, p. 195), quoted this observation without reservation. Frequently seen in the Andamans but not so common as in most places in India.

A female obtained on 17th February has the wing 197 (FAUNA, 199-230)[1]; bill from gape 83 mm., from feathers 60 mm. (60-67), tarsus 56 (60-64), and tail 66 (73-84). These measurements show it slightly smaller than the Indian form and the markings on the head and neck are paler rufous than in others in the Bombay collection.

[43. **Ardeola bacchus** (Bonaparte) (Malay Peninsula) Chinese Pond Heron.

FAUNA **6**: 355 and SYNOPSIS p. 14 state that it is found in eastern

[1] Except where otherwise appearing from the context, measurements in parentheses will be from Stuart Baker's FAUNA.

Assam, Manipur, East Pakistan, and the Andamans. The FAUNA key only refers to breeding plumage and the text says it is like *A. grayii* ' rather more brown and buff on the head and neck and rather deeper brown on the back and scapulars '. The measurements of wing, tail, tarsus, and culmen in the two species overlap to a large extent. In THE BIRDS OF BURMA, p. 532, it is stated that in non-breeding plumage this is not distinguishable from *grayii.* The only record I can trace is Sharpe, CAT. B.M. **26**, p. 212, where a juvenile skin is listed from South Andamans. In the absence of any other record this may perhaps best be omitted.]

*44. **Bubulcus ibis coromandus** (Boddaert) (Coromandel) Cattle Egret.

1 ♀ Choldhara, S. A.: wing 257 (240-260); bill from gape 83 mm., from feathers 60 (60-67); tarsus 56 (60-64); tail 66 (73-84).

Frequent in suitable open country. When disturbed, they formed flocks of 10 to 25 and flew together. None seen in breeding plumage either in November or on this trip.

Abbott and Kloss obtained an adult at Tillangchong, Nicobars (Richmond 1903 : 313). It is not mentioned for either place in the SYNOPSIS (Biswas 1964).

46. **Egretta alba modesta** (J. E. Gray) (India) Large Egret.

One was shot by General Stewart near Port Blair (Hume, *Stray Feathers* **5**: 347) but this is omitted in the SYNOPSIS.

I twice saw larger birds with *E. intermedia* in freshwater marshes, which were more likely to have been Large Egrets than the white form of *sacra.*

*47/48. **Egretta intermedia intermedia** (Wagler) (Java) Middle Egret.

♀ North Button Island, Ritchie's Archipelago, Middle Andamans: wing 352 mm. (304-333, once 354); tarsus 132 [about 114 (once), 122-148]; bill from gape 118; from feathers 97 [68 (thrice), 73-97; 118 (once)]; tail 89.

Occasional. Twice seen with larger birds which were either *alba* or the white form of *sacra.*

Butler (1900 : 151) states that they occur in both groups, but he does not appear to have any evidence in addition to Hume's (1874 : 303) that, though he ' thought he saw it in the Nicobars, it is impossible to be certain '.

Dr. Sálim Ali informs me that he believes *palleuca* Deignan (North Siam) to be untenable, being based on a mistaken premise of bill colour.

Egretta garzetta subsp. Little Egret.

Tytler (Blyth 1863b) saw many, and Hume obtained 3 specimens from the Andamans. None were preserved from the Nicobars, where their

occurrence is doubted by Davison. Butler said they were more numerous than *intermedia* in the Andamans, and Osmaston (1906a : 491) saw flocks in South Andamans. It is omitted from both groups in the SYNOPSIS. I did not notice it though a careful watch was kept.

Hume said the Andaman birds were identical with birds from India, but Walden (*Ibis*, 1874c : 148) identified one obtained by Wardlaw Ramsay on South Andamans on 17 December as true *nigripes* Temm.; but this specimen is listed with *garzetta* by Sharpe (CAT. B. M. **26** : 122) along with others from the Andamans, and one from Trinkut, Nicobars.

As it is quite possible that the black-footed form from Sunda Islands extends to the Andamans and Nicobars, it may be well to leave the race as undetermined until fresh (or even the old) specimens are specifically examined for this character.

*51 **Egretta sacra** (Gmelin) (Tahiti) Reef Heron.

1 ♂ Long Island, M.A. ; 1 ♂ Car Nicobar.

Frequent on rocky shores, occasionally several seen together when flighting to roost. No white forms certainly identified and a few large white egrets were seen in grass-covered snipe-land, where there would be greater probability of *Egretta alba* occurring. The legs are much shorter than in *asha* (*E. gularis schistacea*), and the tail almost touches the ground when sitting. The short tail and legs give it a curious *Pteropus*-like appearance when flying over. The Andaman bird which had enlarged testes is slightly darker and has a dark bill against a parti-coloured greenish-horny one in the Nicobar bird (both noted after drying). The white chin stripe in the Andaman bird is shorter ($1\frac{3}{4}$ in.) than in the other ($3\frac{1}{2}$ in.). Both are paler than a ♂ *Demigretta asha* (*Egretta gularis schistacea*) from the Gulf of Kutch.

The stomach of one contained blennids, mud-skippers, and parrot fishes.

Butler (1900 : 151) refers to Port Blair birds nesting on the rocks and trees on Snake Island in Corbyn's Cove 3 miles away. On 14th May, he saw about 25 pairs of which only one pair was white.

Osmaston (1906a : 491) said they breed from April to June, chiefly on rocky islands, the nest consisting of a few sticks roughly put together and placed in some low bush or between rocks on the ground. The clutch is of two or three eggs.

	Wing	Tail	Tarsus	Bill from gape	Bill from feathers
Long Island ♂	278	90	66	95	75
Car Nicobar ♂	266	87	68	99	77
	(280-293)	(93-98)	(72-77)		

Hume (1874 : 304) quoted Von Pelzeln that three birds from the Nicobars are of small size with shorter bills and shorter tarsi, but com-

paring them with 39 specimens obtained from several places in the Andamans and Nicobars said that the distinctions would not hold good. He added that in white birds the dorsal plumes are rather more disintegrated than in ashy birds, some of them extending fully an inch beyond the end of the tail, which condition was not noted in any ash-coloured bird seen by him. Davison (loc. cit.: 309) said that the white form is more wary than the grey.

52. **Nycticorax nycticorax nycticorax** (Linnaeus) (Southern Europe) Night Heron.

Blyth (1846b) mentions it without comment, presumably having received a specimen from Mr. Barbe or Capt. Lewis. Davison (1874: 315) saw several on the freshwater ponds of Trinkut Island (Nicobars) but did not obtain any. These records are omitted in the SYNOPSIS (Biswas 1964).

54. **Gorsachius melanolophus minor** Hachisuka (Katchal Is., Nicobars) Malay or Tiger Bittern.

This race has been described from the Nicobar Islands, but I have seen no refutation of Boden Kloss's statement (*Ibis* 1927: 526-527) that it is not separable from the typical race from Western Sumatra. Hume obtained specimens at Tillangchong and Camorta.

56. **Ixobrychus cinnamomeus** (Gmelin) (China) Chestnut Bittern.

Butler (1900: 153) said it was common in the Andamans, though Hume had only noted it at Tillangchong and Preparis in the Nicobars, and suggested that it had increased in numbers with the increase of paddy cultivation. He also took eggs in July. Osmaston (1906a: 491) found it common and took many nests between 25th June and 15th August. It is said to be less common in the Nicobars where Abbott and Kloss collected it at Camorta.

57. **Ixobrychus sinensis** (Gmelin) (China) Yellow Bittern.

Hume and Davison considered it uncommon but obtained specimens at Port Blair, Andamans, and Tillangchong, Nicobars. Another was obtained by Abbott and Kloss at Trinkut. Butler suggested that they had since increased in numbers.

Hume also referred to the birds being brighter coloured than any from India, but the matter does not appear to have received more attention later. These records are omitted in the SYNOPSIS.

*88. **Dendrocygna javanica** (Horsfield) (Java) Lesser Whistling Teal.

Not seen on this trip, but 3 adults near 8 ducklings were noted at Dilthamma Tank at Port Blair on 11th November. Butler said it was the common teal of the islands, numerous and resident near Port Blair

and abundant on some of the Nicobars. One he shot on 26th June was about to lay. Osmaston (1906a : 491) found it fairly common near Port Blair and took three nests on the ground in August and September. Curiously, Davison said he did not meet it anywhere but in the Nicobars.

90. **Tadorna ferruginea** (Pallas) (Tartary) Ruddy Sheld-duck or Brahminy Duck.

Bayley-deCastro (1933) refers to a Brahminy Duck captured by a jailor at Port Blair, after a cyclone, in April 1922. There is no other record.

[94. **Anas crecca crecca** Linnaeus (Sweden) Common Teal.

Stuart Baker (*J. Bombay nat. Hist. Soc.* **12** : 251) said that Hume had excluded this from a number of places, but ' from these places must now be struck off the Andamans, Nicobars, and Malabar, in the latter place having been found frequently since GAME BIRDS was written '. This statement is repeated in INDIAN DUCKS AND THEIR ALLIES but I cannot find Stuart Baker's statement, which is mentioned by Butler, that this is based on reliable sight records. Bayley-deCastro (1933) also refers to its occurrence in the Andamans, but lists the Andaman Teal (*Nettion albogularis*) and the Oceanic Teal (*N. gibberifrons*) as two separate species! In the absence of any more definite information, I would drop it.]

*96. **Anas gibberifrons albogularis** (Hume) (Andamans) Grey Teal.

2 ♂♂, 3 ♀♀ Betapur, M.A.

Only one party of 5 birds was seen on a tidal creek in the Middle Andamans. They appear very dark and inconspicuous when seated, either on a log in water or on the shore, but the white patches on throat, nape, axillaries, and wing coverts are conspicuous in flight, which is not unlike that of the Whistling Teal. Winged birds made very feeble attempts at diving. A crest which does not appear to have been mentioned was noticed in the bird in hand. Davison said that he had only heard them utter a low whistle, which was also apparently only uttered at night when feeding. Butler (*J. Bombay nat. Hist. Soc.* **11** : 332) and Osmaston (1906a : 491) have some notes on this species and the latter states that they nest in lofty and often dead trees, a clutch of 10 eggs being obtained at the top of a huge Padouk tree on August 4th. J. H. Williams in the THE SPOTTED DEER (1957, p. 220) refers to ' tens of thousands ' on a freshwater lake on North Reef Island : ' The lake grew mottled brown with them. Thousands of others alighted on the tree-tops like starlings, scrambling over each other and flapping awkwardly to find a foothold.' He shot 20 couple and refers to iguanas (monitors) swimming out and making off with pricked birds.

There are other statements in the book which are rather startling from the natural history point of view. Osmaston (loc. cit.) states : ' it arrives at Port Blair in large numbers at the end of May and remains till October or November. In the winter months they frequent outlying freshwater jheels such as are found near Craggy Island, North Reef Island, Niell, the Brothers, Templeganj and other places '.

The northern population was separated by Fleming as *leucoparea* because of the large extension of white on the head and neck. But, as stated by Delacour (THE WATERFOWL OF THE WORLD, 1961, **2** : 77), this is irregular and varies individually. He adds : ' Such partial albinism is frequent in Ducks confined to a small island range and inbred . . . . captivity-bred Andaman Teal showed various degrees of albinism which increased with inbreeding in successive generations '.

Anas poecilorhyncha subsp. Spotbill Duck.

Bayley-deCastro (1933) shot one in December 1927, after a cyclone, and this appears to be the only record.

114. **Nettapus coromandelianus coromandelianus** (Gmelin) (Coromandel) Cotton Teal.

Though not mentioned in the SYNOPSIS (Biswas 1964), this is a straggler into the Andamans, the records including Wardlaw Ramsay obtaining a single bird at Port Blair, and Capt. Wimberley a pair.

[133. **Milvus migrans govinda** Sykes (Dukhun) Pariah Kite.

Biswas (1964) has drawn attention to its occurrence in the Andamans, relying presumably upon 2 specimens shot by Tytler on Viper Island, near Port Blair. Hume (1874 : 150) expresses the opinion that these birds were carried down by a boat from Calcutta (as another was carried from Madras to Calcutta). I do not think that this conspicuous bird could have remained unnoticed and, as no one else ever noted it in the area, it should be removed from the list of Andaman and Nicobar birds.]

141. **Accipiter badius butleri** (Gurney) (Car Nicobar) Shikra.

(Colour plates of adult and juvenile male *J. Bombay nat. Hist. Soc.* **12** : 684).

Butler who found them in Car Nicobar while in search of *Accipiter soloensis* said that they keep almost exclusively to the tops of high trees, and have a shrill little double cry exactly like that of *Astur badius.*

142. **Accipiter badius obsoletus** (Richmond) (Katchal Is., Nicobars) Shikra.

The specimens obtained by Abbott had crimson irides against orange or yellow in *butleri* and its allies. Two stomachs contained insects and one lizard (Richmond 1903 : 307).

143. **Accipiter soloensis** (Horsfield) (Java) Horsfield's Goshawk.

A winter visitor to the Andamans and Nicobars (SYNOPSIS). Hume (1874, **2**: 141) quotes Von Pelzeln that a young ♀ was killed on Car Nicobar, chasing an Oriole. Abbott and Kloss found it common in Katchal and on the Great and Little Nicobars (Kloss 1903 : 128 and FAUNA **5**: 153) obtaining 12 specimens. They suggest that Von Pelzeln's specimen may have been *A. butleri*. I cannot trace other records.

147. **Accipiter nisus nisosimilis** (Tickell) (Marcha, Borabhum) Sparrow Hawk.

Hume (*Stray Feathers* **4**: 280) received a female killed in October by Capt. Wimberley in the Andamans. Biswas (1964) has drawn attention to its omission in the SYNOPSIS.

*152. **Accipiter virgatus gularis** (Temminck & Schlegel) (Japan) Eastern Sparrow-Hawk.

♂ (wing 159) Wimberleyganj, S.A. ; ♂ (150) ♀ (187) Betapur, M.A.

The FAUNA (**5** : 164) refers to eggs of *nisoides* Blyth (Malacca) being taken from February to April from old nests of crows in the avenues of Port Blair (probably from Wickham, *J. Bombay nat. Hist. Soc.* **19** : 992). Osmaston (1906a : 488) took nests with : (a) 1 young and 2 eggs on the point of hatching and (b) 3 incubated eggs, on 24th and 27th April respectively. The second nest was conspicuous in a leafless tree and looked like a crow's nest but lined with green leaves. In the SYNOPSIS this race is synonymized with *gularis* but not mentioned for the Andamans and Nicobars, being said to be an occasional winter migrant as far west as Burma, East Pakistan, and India.

The first male is in immature plumage and differs from juveniles of *besra* Jerdon from the Palni Hills in : (1) having the feathers of the back unicolor and not edged with buff or rufous, (2) the mesial throat streak narrow, and (3) the breast being barred across and not marked with broad brown streaks.

Hume measured a ♂ wing 147 mm. (5.8 in.) and 2 ♀♀ 185 and 180 (7.3 and 7.1 in.). Stuart Baker has referred to the curious smallness of the males.

The first bird was taken in open country and looked very like a pigeon when going over. Davison (1874 : 141) thought they were very rare and only noted them twice sailing in circles over gardens.

162. **Spizaetus cirrhatus andamanensis** Tytler (Port Blair, South Andaman Island) Crested Hawk-Eagle.

Several were seen circling over forest. In *Proceedings, Asiatic Society of Bengal*, 1865, p. 112, Tytler says it is found in mangrove forests and that he had found fish and crabs in them. Butler saw one

capture a myna and another a koel. Hume (1874 : 144) noted them at Great Coco.

*173. **Haliaeetus leucogaster** (Gmelin) (Prince's Is., Indonesia) White-bellied Sea Eagle.

Occasionally seen on seashore and in tidal creeks. One fully fledged brownish young, attended by parent seen on 12th February. The very distinctive *kak-kak-kak* call was not noticed. Hume (1874:143) found a nest 80 ft. up in a tree on Nancowry Island. Tytler (1867) saw it on Narcondam. Osmaston (1906a : 488) reported nests on high trees on Craggy, Sir Hugh Rose, and the South Cinque Islands. Osmaston (1908:358) saw it on Barren Island. I saw a pair on Little Button Island, which were probably resident there. In November 1963, I saw a large brown bird with a pure white wedge-shaped tail and again on 1st March 1964 another large eagle with white underparts, a dark chin, and similar tail. The only other fishing eagle with a graduated tail is *albicilla*, but both were probably *leucogaster*.

It is also common along the sea-coast in the Nicobars (Abbott & Kloss in Richmond 1903 : 306).

[175. **Icthyophaga ichthyaetus ichthyaetus** (Horsfield) (Java) Grey-headed Fishing Eagle.

Tytler is quoted by Blyth (1863b) as guessing at the identity of the sea eagle which flew over his house and which 'looked like *ichthyaetus* but was too far and high up to judge accurately'. Blyth suggests this may be correct as *humilis* (S. Müller). This was negatived by Hume and was omitted until revived by Biswas (1964) and may perhaps be best ignored.]

[190. **Circus macrourus** (S. G. Gmelin) (Voronezh, southern Russia) Pale Harrier.

Ferrar (1932 : 449) refers to an immense number of Pale Harriers arriving at Port Blair in 1929-30 : 'Every patch of rice had one of these birds over it.' They also arrived in Stewart Sound 90 miles north of Port Blair some time in November, and sat on fences and trees in great numbers, apparently exhausted. He states that, though conditions were excellent, he saw only 3 snipe where a record bag was made the previous season, and enquires if they could have been frightened away by the harriers. The following season was a fair one for snipe and no Pale Harriers were seen,

As no other observer has recorded this from the Andamans and Nicobars, it is probable that these notes refer to Montagu's Harrier (*C. pygargus*) and it may not be worth while adding this to the avifauna, though the observations are interesting.]

191. **Circus pygargus** (Linnaeus) (England) Montagu's Harrier.

Butler (1899: 685) saw an immature bird in May which he thought was of this species. He later found a skeleton which was too small for *aeruginosus* and which may have been of this too.

Osmaston (1906a : 488) says they are common in the open country around Port Blair, from November to March.

Biswas (1964) refers to the omission of the Andamans from its range in the SYNOPSIS.

*193. **Circus aeruginosus aeruginosus** (Linnaeus) (Sweden) Marsh Harrier.

Davison (1874 : 150) refers to a pair of young birds at Aberdeen, Port Blair, in May; Butler saw it several times, and Osmaston (1906a : 488) said it was less common than Montagu's, but apparently frequently seen. I saw an adult in November 1963.

It is omitted for the Andamans in the SYNOPSIS (Biswas 1964).

*200. **Spilornis elgini** (Blyth) (South Andaman Island) Dark Andaman Serpent Eagle.

1 ♀ Mannarghat, S. A.

***Spilornis cheela davisoni** Hume (South Andamans) Pale Andaman Serpent Eagle.

2 ♀♀ Pochang, S. A.; Bakultala, M. A.

A pale and a dark form of serpent eagle occur in the Andamans. The dark form was first named *elgini* by Blyth in 1863 and the pale form separated as *davisoni* by Hume in 1873. Stuart Baker accepted the pale *davisoni* as a race of *Spilornis cheela* restricted to the Andamans and kept the dark *elgini* as a separate species described from South Andaman Island, and said to occur in both the Andamans and Nicobars (FAUNA 7 : 686), though Hume (1874 : 147) specifically stated that it had not been seen in the Nicobars. The 3 specimens obtained in the Andamans are all females, two pale and one dark (Mannarghat). Both the pale birds have the wing 393 mm. (374-407) against 380 (344-368) in the other, more yellowish legs and feet, which appear coarser and stouter than in the dark *elgini*, but the other differences regarding the scales on the tarsus and the papillae on the soles (Hume, loc. cit. : 148) are difficult to confirm. Ripley (SYNOPSIS : 62) combines the pale and dark forms in the Andamans and synonymizes *davisoni* with *elgini*. If Ripley's interpretation is correct, the Nicobar record [presumably the one specimen in the British Museum referred to by Blanford (2 : 362)] would be either a straggler from the Andamans, or evidence that the trend to dimorphism is shared by the subspecies inhabiting the Nicobars too.

Light and dark birds were seen at the same camp but, in the several pairs glassed, both were always of the same kind. The last bird shot on

22nd February was one of a pair and had three enlarged follicles in the ovary. All were obtained before noon and had empty stomachs. Often seen in mangrove forests.

Osmaston (1906a : 488) saw one capture an eel about a foot long in shallow water.

Butler (1899 : 684) thought that birds shot along the mangrove creeks feeding on crabs were nearly always pale, while those shot on clearings etc. more inland were usually *elgini*. My three specimens were obtained exactly under these circumstances !

With the little evidence that I have seen, I am inclined to the view that *elgini* and *davisoni* are two separate species.[1]

201. **Spilornis cheela minimus** Hume (Camorta, Nicobar Islands) Serpent Eagle.

Butler (1899 : 685) saw it on Teressa and Katchal Islands.

Richmond (1903) refers to specimens from Camorta and Katchal and records that Abbott & Kloss also saw it on Trinkut and Little Nicobar. In the SYNOPSIS the island of Nancowry is added to this range. The male wings measured 256·5-284·5 mm. and the female 288-292 mm. The stomachs of the three specimens contained remains of lizards, portions of a small fowl and a small crab (Richmond, loc. cit.). Gurney (*Ibis* 1878 : 102) refers to the considerable prolongation of the hooked point of the upper mandible.

202. **Spilornis cheela klossi**[2] Richmond (Pulo Kunyi, Great Nicobar Is.) Serpent Eagle.

In the SYNOPSIS, the distribution is given as the Great Nicobar and southern Nicobar Islands, while Richmond stated that it was found on Great Nicobar only. The stomachs of the birds obtained by Kloss contained remains of lizards, rats, a small bird, and an Emerald Dove.

[**Microhierax latifrons** Sharpe

Blanford did not admit this to the Nicobar list as both the records (*Stray Feathers* **8** : 496) and *Ibis* (1881 : 274) were based on specimens obtained from a dealer.]

*203. **Pandion haliaetus haliaetus** (Linnaeus) (Sweden) Osprey.

At Betapur, Middle Andamans, I twice saw this bird in a tidal creek, and later another on the sea-side diving and splashing into the water in typical osprey style. I do not think there is much room for doubt in this identification, which adds this species to the avifauna of

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[1] Dean Amadon (1964, Taxonomic notes on Birds of Prey. *Amer. Mus. Novit.* No. 2166) treats *davisoni* as a race of *cheela* and *elgini* as a separate species.

[2] Dean Amadon (loc. cit.) treats this as a separate species.

the area. In view of the few records of this species nesting in Indian limits, it may be worth noting that Jim Corbett in THE TEMPLE TIGER (1957) page 96 states that it nested for many years on the same tree in the Sarda River on Kumaon-Nepal border.

209. **Falco peregrinus japonensis** Gmelin (off Japan) Peregrine Falcon.

Winter straggler. Hume (1874 : 140) saw a pair on Preparis Island and Col. Tytler on Ross Island. General Stewart shot one at Port Blair which was recorded as *peregrinus* (Hume 1876 : 279). In the SYNOPSIS *japonensis* is said to occur but I do not know if a specimen was examined.

211. **Falco peregrinus peregrinator** Sundevall Shahin.

The type specimen was taken at sea in latitude 6°20′N. between Ceylon and Sumatra, 70 Swedish miles off the Nicobars. The mileage is converted into 'about 700 English miles' in the SYNOPSIS, but this is doubtless in error, for Ball (1873 : 52) also refers to 70 miles. One collected by Abbott at Kamorta in February (Kloss 1903 : 97) is listed by Richmond (1903) as *Falco peregrinus* Tunstall. Dr. Dillon Ripley tells me (*in epist.*) that it appears to be a small male of this race: wing 310 [265-295 (one 339)], though its general tone of coloration is rather paler than normal for this form.

Falco tinnunculus subsp. Kestrel.

Biswas (1964) refers to the occurrence of '*tinnunculus/interstinctus*' in the Andamans being overlooked in the SYNOPSIS. From a subsequent letter I understood that he was not able to verify either race but meant an alternative identification, presumably Butler's (1899 : 687) mention of a Capt. Orchard seeing 'an unmistakable kestrel hovering .... at Port Blair in October'. I wonder if such a record, unsubstantiated by anyone else before or after, is worth retaining.

225. **Megapodius freycinet nicobariensis** Blyth (Nicobar Is.) Megapode.

Islands of the Nicobar group (except Choura and Car Nicobar) lying north of Sombrero Channel (SYNOPSIS). Hume (1874 : 72) refers to the stomach of one shot at Tillongchong containing 'a good deal of sand, fragments of quartz and specimens of *Scarabus plicatus* and *Helicina zelebori*'.

Hume (loc. cit. : 114) refers to Mr. Hawkins, the lighthouse keeper at Table Island (at the northernmost end of the Andamans), describing a 'brown hen-like bird which he occasionally shot and which although it may have been merely one of the wild [? feral] hens from the neighbouring Cocos, still, from what he said of the large feet and red

skin about the face, seemed to savour strangely of the Megapod, and this suspicion gains strength from the fact that on the western shore of the island ...... I came upon a mound, which in every respect resembled, so far as external appearance went, the mounds that I so closely examined in Galatea Bay'. Pollok (1879, **2** : 16) refers to 'one of the Megapodidae' being shot on Great Coco.

C. Boden Kloss (1903, footnote p. 328) says that the megapode also occurs in the Cocos presumably referring to these statements, and suggests that it has either been introduced by Malays or been eliminated from the Andamans by the introduction of the civet (*P. tytleri*).

Abbott notes (Richmond 1903 : 311) that their eggs are excellent when fresh and excrement very foul. Butler (1899 : 692) and St. John (*J. Bombay nat. Hist. Soc.* **12** : 212) have notes on the nests and eggs. Hume describes the call as a cackling *kuk-a-kuk-kuk* quickly repeated.

226. **Megapodius freycinet abbotti** Oberholser (Little Nicobar Island) Megapode.

Restricted to Great and Little Nicobar Islands.

*246. **Francolinus pondicerianus pondicerianus** (Gmelin) (Pondicherry, India) Grey Partridge.

This was introduced at Port Blair in about 1890 (Butler 1899 : 691) and has established itself within the immediate vicinity, where the forest has been removed and treeless, grass-covered hill-tops remain. At Haddo, Port Blair, birds may be heard calling within city limits and also seen from the Government Guest House. Shooting is prohibited, but they have not spread very far. I am recording the race as mentioned in the SYNOPSIS.

254. **Coturnix chinensis trinkutensis** (Richmond) (Trinkut Is., Nicobar Group) Bluebreasted Quail.

Only one specimen was collected by Abbott & Kloss and examined by Richmond (1903), though they reported it as 'common in open grasslands of Trinkut and Camorta'. Butler also found it common on Car Nicobar.

*311. **Pavo cristatus** Linnaeus (India) Common Peafowl.

This was introduced on Ross Island (opposite Port Blair) around 1868, where Hume in 1873 reported them as having thriven, though introduction on the mainland (South Andaman) had not been successful. Pollok (1879, **1** : 33) stated that hybrids between Indian and Burmese (*muticus*) peafowl were common at Port Blair. Peafowl disappeared during the Japanese occupation (1940s) but some more have been introduced by the present administration. I saw 5 or 6 birds in November 1963 which were not wild and would perhaps be best described as 'domesticated'.

Turnix tanki subsp. Button Quail.

Hume (1873 : 310) referred to a single indifferent specimen similar to *maculosus*, with a perfectly white abdomen, for which he suggested the name *albiventris*. Later (1874 : 281-283) he preferred to leave it with *joudera* Hodgs. (= *tanki*) and said it was rare in the Andamans but not uncommon on Camorta, Nicobars. Again (*Stray Feathers* **4** : 293), he said that other specimens which had come to hand left little doubt as to its distinctness 'though it must be admitted that the name was not happily chosen'. This was accepted in Blanford's FAUNA (**4** : 150) where the description reads : 'Back in adults with bold black and rufous markings, while in *tanki* the back in adults is brown, with slight black vermiculations; rufous confined to collar'. Stuart Baker merged it with *tanki* and thus it has remained since. Butler (1899 : 693) found it common in areas with undulating plains of grassland on Teressa, Camorta, and Car Nicobar. Seymour Sewell (1922, p. 980) found their crops invariably full of grass seeds.

*330. **Rallus striatus obscurior** (Hume) (Andamans) Bluebreasted Banded Rail.

Osmaston (1906a : 489) said it was very common in the Andamans and that it did not readily rise and had a very heavy flight. He found a number of nests on swampy ground, well concealed and with up to six eggs, between 15th June and 15th August.

I got only one glimpse of a rail in South Andaman, which was probably this species.

Butler (1899 : 694) said it was common on both groups and that it bred more or less throughout the year, but added : 'I have known of nests in June, July and November in the Andamans and took a nest in Car Nicobar on 30th August. I also caught several very small chicks of this species in September and October'. He caught several in thick jungle in traps set for *E. canningi*, and said the note was a deep croak, very like that of the Chestnut Rail. When caught, the chicks kept up an incessant plaintive call note, half whisper and half whistle.

Hume (1875 : 389) described the young of this form as *Hypotaenidia abnormis*.

*333. **Rallina canningi** (Blyth) (Port Canning, Andamans) Andaman Banded Rail.

At Wrightmyo, a pair of rails, which appeared almost red, rapidly scuttled from a stream in evergreen and disappeared into the undergrowth. The bush-policeman said they were responsible for the deep low booming heard several times in heavy forest, a call which was more suggestive of a pigeon. The single specimen of the pigeon *Caloenas* was obtained in the same patch and I am unable to express any opinion.

Butler (1899 : 695) snared 80 within a square mile in 2 months. The call, he says, is ' a curious deep croak, sounding something as if a man were trying to say *kroop*! *kroop*! with his mouth under water. The alarm call uttered by a snared bird when approached is a sharp *chick*! *chick*! and when caught it sometimes utters a cry rather like that of a wounded rabbit'. He added : ' it fed principally on beetles, grasshoppers, worms, small snails, caterpillars etc. In the case of large grasshoppers the prey is held in the bill and shaken as a terrier would do a rat, flung down, pounced on, and worried again until nearly dead and then swallowed.' The plumage of young birds and the colours of their soft parts are also noted.

337. **Porzana pusilla pusilla** (Pallas) (Dauria) Baillon's Crake.

Davison obtained a single specimen at Port Mouat and Butler another. These are overlooked in the SYNOPSIS (Biswas 1964).

*345. **Amaurornis phoenicurus insularis** Sharpe (Andamans) White-breasted Waterhen.

1♂ Wrightmyo, S.A.

***Amaurornis phoenicurus leucocephalus** Abdulali (Car Nicobar) Whiteheaded Waterhen.

1♀ Car Nicobar.

After I had described the latter race (1964), Mr. W.W.A. Phillips kindly examined the material at the British Museum. He states that birds from both the Andamans and the Nicobars show more white on the head than those from India, but in his opinion there is no justification for separating the Nicobar birds from the Andaman race. It would appear that a closer examination of additional material is necessary.

This species was quite often seen or heard either in mangrove or near a stream. On 13th February at dusk, a pair 10 feet up in trees 20 yards apart appeared to be *tuk-tukking* to each other. The ♂ shot on 11th February had the gonads undeveloped. Osmaston (1906a : 490) took many nests, usually with 4 eggs in June and July.

It appears to be widely distributed, having been reported from many places both in the Andamans and Nicobars, and also from the hot springs on Barren Island (Richmond 1903).

*346. **Gallicrex cinerea cinerea** (Gmelin) (China) Water Cock or Kora.

Davison saw it in sugarcane fields and Butler noted two or three.

We put one up out of grass near water in paddy fields at Wimberleyganj, S. A., and Bakultala, M. A.

***Gallinula chloropus orientalis** Horsfield (Java) Malay Moorhen.

1 o? Port Blair, S. A.

One specimen was shot and skinned by Maxie Young near Port

Blair on 6th March 1964. It differs from others in the Bombay collection by its bright red frontal shield extending backward as far as a vertical plane passing through the eyes. The wing measures 170 mm. and the bill from gape 30 mm. Dr. Ripley has identified this bird as *G. c. orientalis*, which is an addition to the Andaman and Indian avifauna.

365. **Vanellus cinereus** (Blyth) (Calcutta) Greyheaded Lapwing.

Mentioned in Blanford's FAUNA as occurring in the Andamans, probably on the strength of the single specimen from Port Blair shot by Gen. Stewart (Hume, *Stray Feathers* **5** : 347).

371. **Pluvialis squatarola** (Linnaeus) (Sweden) Grey Plover.

Hume (1874 : 287) observed several in MacPherson's Strait and Davison secured one at Port Mouat, South Andamans. These records are omitted in the SYNOPSIS as noted by Biswas (1964).

*373. **Pluvialis dominica fulva** (Gmelin) (Tahiti) Golden Plover.

1 o? Wrightmyo, S. A.; 1 ♂, 1 ♀ Car Nicobar, 13th March.

Hume (1874 : 288) said they had been shot in every month from December to May, and again in June, July, and September, but none were in breeding plumage. Butler also shot what he believed were immature birds in June. I saw a party at the Port Blair aerodrome in November 1963, and during February-March they were often seen, usually in small parties in drying paddy fields, snipe grounds, mangrove creeks, hockey grounds, and rocky sea-shore. Also, on 7th March on Car Nicobar where Shekar obtained specimens on 13th March.

3 birds: wings 165 (2), 171 (♀) mm. against measurements of 160-165 in the FAUNA. THE HANDBOOK OF BRITISH BIRDS indicates 165-174.

*374. **Charadrius leschenaultii leschenaultii** Lesson (Pondicherry) Large Sand Plover.

Hume, Ramsay, Butler, and Osmaston noted it and obtained specimens in the Andamans and/or Nicobars. As pointed out by Biswas (1964), these records are overlooked in the SYNOPSIS.

I think I saw a pair at Chiria Tapoo, South Andamans, on 15th February.

377. **Charadrius asiaticus veredus** Gould (Northern Australia) Sand Plover.

Ball's record from the Andamans, a male in winter plumage shot by Dr. Dobson in May (1872 : 288), still remains the only one of this race from Indian limits, two of the typical form having been taken at Vengurla (west coast south of Bombay) and in Ceylon.

379. **Charadrius dubius curonicus** Gmelin (Kurland) Little Ringed Plover.

Davison (1874 : 290) obtained a specimen with a 4½ in. (114 mm.) wing at Aberdeen, South Andamans, and Hume saw it on the Coco and Preparis Islands. Ramsay also obtained specimens in South Andamans (Walden, 1873 : 316) and Butler saw it at Port Blair. I saw Ringed Plovers near Port Blair in November and again on the creek at Betapur, Middle Andamans, on 24th/25th February. The Andamans have been omitted from the range of this species in the SYNOPSIS (Biswas 1964).

*384. **Charadrius mongolus atrifrons** Wagler (Bengal) Lesser Sand Plover.

1 ♀ Choldhari, S. A.; 2 ♀♀, 1 o? Car Nicobar.

This species was common, being seen quite often in tidal creeks and near the sea. Also seen with a party of turnstones in a field a hundred yards from the sea at full tide. Hume (1876 : 293) received skins of what he thought were young birds obtained in May, July, and September, but as stated in the FAUNA (**6**: 174) it is unlikely that it breeds here. Ramsay (Walden 1873) got it in South Andamans. The four specimens are more worn and greyer than others in Bombay, and the forehead also purer white, but Dr. Ripley to whom specimens were sent identifies them as of this race.

*385. **Numenius phaeopus phaeopus** (Linnaeus) (Sweden) Whimbrel.

1 ♂, 2 ♀♀ Long Island, M. A.; 1 ♀ Car Nicobar.

Hume and Walden noted them in the Andamans and Nicobars and Hume thought that they did not differ from those found in England. Abbott & Boden Kloss obtained specimens in the Nicobars, but they were not racially identified by Richmond. Biswas (1964) had drawn attention to the omission of these records in the SYNOPSIS.

I found it quite common in suitable localities in South and Middle Andamans, and Shekar obtained it at Car Nicobar. All our specimens (4) are duskier above than any of the specimens available in Bombay, which all show a more spotted appearance. One of my specimens was sent to Dr. Ripley for subspecific identification, who has identified it as of the typical race. The bills measure: 3 ♀♀ 84-96, avg. 90 ; 1 ♂ 80.

Curiously the 8 specimens in Bombay are all males.

One contained remains of the crab *Thalamita crenata* (Latrielle), and another of *Sesarma longipes* Krauss.

*388. **Numenius arquata orientalis** C.L. Brehm (East Indies) Curlew.

Birds from the Nicobars were identified as *lineatus* (now synonymized with *orientalis* C. L. Brehm) by Herr Von Pelzeln (Ball 1873 : 85).

Hume (1874 : 296) refers to two specimens from Port Blair obtained on 16th August and 24th September (both rather early dates for winter migrants so far south), one a female excessively pale and the other a male excessively dark. He adds : ' Both are slenderer and smaller than any specimens of *lineatus* I have ever seen. The male, long as is his bill, is scarcely bigger than a Whimbrel.'

Though I have an impression that I saw several, I have specific record only for one seen on Long Island on 27th February. This species is omitted from the Andamans and Nicobars in the SYNOPSIS (Biswas 1964).

*394. **Tringa totanus eurhinus** (Oberholser) (Tso Moriri Lake, Ladakh) Redshank.

1♀ Choldhari, S.A. ; 1♂ Long Island, M.A.

Davison (1874 : 299) noted this bird as common from the first week in September to 5th May, along the salt-water creeks and mangrove swamps, also perching among the mangroves at high water. One was also shot in June. Walden (1874c : 147) also refers to specimens from Port Blair on 31st May and 12th July. Pelzeln (Ball 1873 : 85) noted it in the Nicobars.

I saw it in November and several in South and Middle Andamans during February. I cannot racially identify the specimens I obtained, but Richmond names one collected by Boden Kloss at Kamorta in February 1901 as *eurhinus* and I am leaving all under this name.

Biswas (1964) has drawn attention to the omission of this species from the Andamans and Nicobars in the SYNOPSIS.

*396. **Tringa nebularia** (Gunnerus) (Norway) Greenshank.

Hume (1874 : 299) did not obtain it and only referred to a doubtful record by Von Pelzeln in the Nicobars.

I saw it at Port Blair in November and at Bakultala, Middle Andamans, on 22nd February.

*397. **Tringa ochropus** Linnaeus (Sweden) Green Sandpiper.

I saw one in November and Butler said it appeared scarce though he shot one or two during the season.

*398. **Tringa glareola** Linnaeus (Sweden) Wood Sandpiper.

Hume said they were not common but Davison met it occasionally around Port Blair and, though he did not see it in the Nicobars, he got it at Acheen, North Sumatra. His three specimens from Port Blair were killed in the first week of November.

I saw a single bird on 11th and several on 14th February.

*400. **Tringa terek** (Latham) (Terek River on Caspian Sea) Terek Sandpiper.

1♀ Betapur, M.A.: wing 132 ; bill 49 mm.

Hume recorded it as common in the neighbourhood of Port Blair, and added that specimens killed as late as mid-April showed no signs of their breeding plumage. Davison saw large flocks in the creeks and noted them as settling on the mangroves at high tide. I shot one out of a party of 10 to 12 on an island at Betapur, where they had settled with some *Charadrius mongolus*.

As in other shore birds the fresh skin appears more grey and less brown than the older ones.

*401. **Tringa hypoleucos hypoleucos** Linnaeus (Sweden) Common Sandpiper.

Common everywhere near water. At Betapur, while punting up the creek at dusk, we saw many single birds, and also twos and threes, flying towards the mouth of the creek, presumably to roost together. Davison found them present on 12th May and Hume noted the first returned bird as obtained on 24th August. Osmaston (1906a: 490) has almost identical dates. Butler records a slightly wounded bird swimming hither and thither, two feet under water. I saw it on Car Nicobar.

*402. **Arenaria interpres interpres** (Linnaeus) (Sweden) Turnstone.

1♂ Choldhari, S.A.

Hume noted it on many islands in the Andamans and Nicobars, the last on 29th April in almost full breeding plumage. His seven specimens were all females. Butler found them still abundant in May at Port Blair and again in the Nicobars in September.

I shot one out of a flock mixed with Lesser Sand Plovers on South Andaman and also noted it on North Button Island in Ritchie's Archipelago.

The tail measurements 76-79 mm. in the FAUNA (**5** : 155) are in error and should be nearer 55.5 to 61.5 mm. (THE HANDBOOK OF BRITISH BIRDS, 1945, **4** : 224).

*406. **Capella stenura** (Bonaparte) (Sunda Islands) Pintail Snipe.

♂ Bakultala, M.A.

This is the common snipe of the Andamans, and Ferrar (1932) cites a bag of 50½ couple to two guns. Hume and Butler state that it is common from September to early May, and Hume refers to two each in June and July. In February I found them common in suitable localities which were few and appeared to be drying up. J. Miles Stapylton (*J. Bombay nat. Hist. Soc.* **36** : 507 and **37** : 491-2) recorded them on 28th August, and Bayley-deCastro (1933) said that they were

invariably present by the middle of August and that he had also seen them on 25th July. One wonders, as did Ferrar, whether they leave the island, or find their food in mangroves and fern (*Asplenium acerifolium*) swamps as the fresh water dries up. Hume also saw it in the Nicobars, though this is overlooked in the SYNOPSIS (Biswas 1964). In flight, the bird appeared darker and slower than the fantail and I thought that in flight it held its bill nearer the vertical creating a more compact profile.

[407. **Capella megala** (Swinhoe) (Between Takoo and Peking, China) Swinhoe's Snipe.

Bayley-deCastro (1933) refers to one shot in the Andamans, but his omission of the Fantail Snipe (*C. gallinago*) and some other errors in his note indicate caution in accepting this record, though it occurs in small numbers in eastern India, south into Ceylon.]

408. **Capella media** (Latham) (England) Great Snipe.

Bayley-deCastro (1933) stated he twice shot Great Snipe, weighing 7¼ and 7⅝ oz., 'behind the butts of the rifle range.' This record is omitted from the SYNOPSIS.

*409. **Capella gallinago gallinago** (Linnaeus) (Sweden) Fantail Snipe.

Hume, Butler, Osmaston, and Ferrar all refer to the rarity of this species in the Andamans, Butler stating that there was not one of this species among the 300 odd birds he shot during the season.

In mid-February I shot and handled a dozen snipe at three separate places, and they included four fantail.

410. **Capella minima** (Brünnich) (Denmark) Jack Snipe.

This has been recorded once from the Andamans, being the first snipe shot by Lt. H. Turner on 25th November 1896 (Finn, *J. Asiat. Soc. Bengal* **46**, Part II, No. 2 : 525).

413. **Calidris tenuirostris** (Horsfield) (Java) Eastern Knot.

Wardlaw Ramsay obtained a specimen near Port Blair (*Stray Feathers* **4** : 294).

415. **Calidris ruficollis** (Pallas) (Southern Transbaikalia) Eastern Little Stint.

This is noted from the Andamans and Nicobars (SYNOPSIS). Hume (1874 : 298) identified 12 specimens from this area as *minuta* and objected to Lord Walden naming a bird collected on 24th January as *ruficollis* as it was not possible to tell them apart in winter plumage. Stuart Baker (**6** : 236) said that it was possible to separate *ruficollis* by its larger size. Butler later refers to *ruficollis* as fairly

common along the Andaman and Nicobar coasts in winter, seeing them up to the end of May. Osmaston (1906a : 490) also shot one at Nadakachang Swamp, Andamans, in January.

416. **Calidris minutus** (Leisler) (Germany) Little Stint.

Taken from December to June in the Andamans and Nicobars (Hume 1874 : 298). This is not mentioned as occurring in this area in the SYNOPSIS.

418. **Calidris subminutus** (Middendorff) (Stanovoi Mountains and mouth of the Uda) Longtoed Stint.

Butler says: 'I believe I shot the Longtoed Stint at Port Blair, but cannot find it among my notes'. Osmaston (1906a : 490) shot one in the Andamans in March. Biswas (1964) draws attention to its omission from this area in the SYNOPSIS, and also to a doubtful record from the Nicobars (?).

422. **Calidris testaceus** (Pallas) (Holland) Curlew-Sandpiper.

Davison and Butler record it both from the Andamans and Nicobars from September to April and refer to specimens taken in June and July. These areas are omitted from the SYNOPSIS (Biswas 1964).

Limicola falcinellus subsp. Broadbilled Sandpiper.

Davison and Butler record it from both the Andamans and the Nicobars from September to April, and refer to specimens in June and July. These areas are omitted from the SYNOPSIS (Biswas 1964).

*434. **Dromas ardeola** Paykull (India) Crab Plover.

1 ♀ North Button Island.

Hume (1874 : 293) collected 4 specimens in the Andamans and considered it rare. Osmaston (1906a : 490) said they were not common but saw 60 or 70 on Baratang Island. Butler saw a flock of 60 or 70 birds on a long low reef exposed by low tide at Car Nicobar. Abbott saw them at Katchal and Great Nicobar. I saw pairs on North and Middle Button Islands.

The specimen from North Button Island has the wing 213 mm. (FAUNA, 201-210); bill 59 (54-56); tail 75 (65-75). My measurements of the wing and bill agree with those noted by Hume. Hume (loc. cit.: 62) records that one had fed entirely on the crab, *Gonodactyla chiragra*.

*438. **Esacus magnirostris magnirostris** (Vieillot) (Australia) Great Stone Plover.

1 ♀ North Button Island.

Hume (1874 : 293) obtained it at Great and Little Coco and at Corbyn's Cove, a few miles south of Port Blair, taking eggs at Little

Coco and Corbyn's Cove. M. Boning took eggs in April (FAUNA **6**: 82). Osmaston (1906a : 490) said that one or more pairs frequented the shore of almost every island.

We saw three birds on North Button Island together with the Crab Plovers, and again on Middle Button. The stomach of the specimen contained pieces of shells. The ovaries were granular, wing 273 mm., bill 79, and tarsus 80 mm.

This species has not been recorded from the Nicobars, though the same race is said to occur again on the coasts and islands of Malaya, and further to Australia. The skin obtained by me was sent to Dr. D. L. Serventy of the Western Australian Regional Laboratory, Perth, for examination. He confirms that it is identical with those from Australia and concurs with recent studies on this species that no new race should be recognized.

443. **Glareola pratincola maldivarum** J. R. Forster (Open sea in the latitude of Maldive Islands) Collared Pratincole.

Said to occur occasionally as a migrant in the Andamans and Nicobars (Hume 1874 : 286). Osmaston (1906a : 490) shot one of a pair at Nadakachung Swamp early in March. It is omitted in the SYNOPSIS for the Andamans and Nicobars, though there are specific records of *G. orientalis* Leach, from the Coco Islands and South Andamans (Walden 1874c : 146).

459. **Chlidonias leucoptera** (Temminck) (Mediterranean) White-winged Black Tern.

Obtained by Mr. de Roepstorff in South Andamans (Blanford, FAUNA **4**: 308).

461. **Gelochelidon nilotica affinis** (Horsfield) (Java) Gullbilled Tern.

The only record from the Andamans and Nicobars appears to be a 'rather small young female, the primaries very dark', wing 292 mm., obtained by Capt. Wimberley in South Andamans in November (*Stray Feathers* **4**: 294).

*466. **Sterna dougallii korustes** (Hume) (Andaman Islands) Roseate or Rosy Tern.

1 ♀ North Button Island : wing 218 mm.

On 29th February, I shot one of this species out of a large flock of *S. sumatrana* (q. v.) on North Button Island. Both species have a strikingly beautiful rosy tinge on the breast but, while there are other differences, my attention was drawn to this bird by its red legs and feet compared to black in the other.

Butler also did not find it as common as the Blacknaped Tern, and said that it disappeared from Port Blair after breeding.

*468. **Sterna sumatrana sumatrana** Raffles (Sumatra) Blacknaped Tern.

3 ♂♂, 6 ♀♀ North Button Island.

On 9th February, while between North Sentinel and the west coast of South Andamans, I saw a large flock of some 200 terns wheeling about over the sea in close formation. They often broke up into two or three flocks, but re-joined and flew around in large irregular circles, high and low over the sea, but too far away for me to identify. Later, on 29th February I saw many similar terns, longwinged, white, and flying close to each other in parties of 5 to 15 and collecting (*c*. 500) on a sandpit on North Button Island. Specimens obtained (10 to 2 barrels !) were of this species, all with black legs and feet and bills. On closer examination the bills were noticed to have small yellow tips about 16 mm. in length. Nine sexed (3 ♂♂, wings 215, 216, 227; 6 ♀♀, wings 208-224, avg. 213) showed no sign of breeding. As was noted by Hume, the males have larger bills, 36 mm. against 33-34 in females.

Blyth (1846b) said it bred abundantly in the Nicobars. Butler said it arrived at Port Blair in numbers at the end of April, bred in the neighbourhood, and was hardly seen anywhere after September. Osmaston (1906a : 491) said they frequented the more sheltered east coast during the south-west monsoon (May to October) and the west coast for the remaining six months. They bred on the small rocky islets off the east coast from May to July, laying one or two eggs.

* **Sterna anaethetus** subsp. Brownwinged Tern.

1o? Ross Island, S.A., 13 November 1963.

On 13th November, I picked up one dying on Ross Island, South Andamans. Except for the smaller size, wing 246, bill 40, tail 127, I can find no other character by which I can separate this from specimens marked *fuscata*.

Blyth (1863b) refers to a specimen from the Andamans, and Butler calls it a straggler to the Andamans during the winter months. He also noted some which hung around Port Blair for a few days after rough weather in November. It is significant that he does not refer to *Sterna fuscata* (q.v.) at all.

474. **Sterna fuscata nubilosa** Sparrman (India Orientalis) Sooty Tern.

Breeds in the Andamans (SYNOPSIS). Though Stuart Baker (FAUNA **6** : 144) refers to its occurrence in the Andamans, I cannot trace the original record nor that of its breeding there.

*479. **Sterna bengalensis bengalensis** Lesson (Coasts of India) Lesser Crested Tern.

2 ♀♀ North Button Island, M.A.: wing 290, 280; bill 52, 54; tail 112, 110; tarsus 23 (2).

I shot two out of a large party of terns, mostly *sumatrana*, on North Button Island on 29th February, both females. Davison got 3

specimens (all females) on the north coast of Camorta, Nicobars (1874 : 318). The soles of the feet of one of my specimens were bright yellow all over (including webs) and only under the toes in the other. Their bills, first noted as bright yellow, were orange on the following day.

This species has also been recorded in Nicobars (Blyth 1846b, and 1863b) but is not mentioned for either the Andamans or Nicobars in the SYNOPSIS.

481. **Anous stolidus pileatus** (Scopoli) (Philippines) Noddy Tern.

Blyth listed it from the Andamans on the basis of a specimen in the Indian Museum (1863b). Hume (1874 : 321) did not obtain it but he refers to several specimens from the Andamans in Col. Tytler's collection. Though known to breed in the Laccadives (FAUNA **6** : 146), it is omitted entirely in NIDIFICATION. Ripley (SYNOPSIS) adds that it nests on small islets in the Nicobars.

Stuart Baker (loc. cit.) refers to their laying a single egg on the bare rock with no nest; but Peter Child (1960, *Atoll Research Bulletin* No. 74 : 9) states that in the Gilbert and Ellice Islands (mid-Pacific) the favourite nesting place is on the butt of a coconut frond, in the axil between the butt and the main trunk. A rough nest is made of twigs, dead leaves, roots, and coconut fibres.

482. **Anous tenuirostris worcesteri** (McGregor) (Cavilli Island, Sulu Sea) Whitecapped Noddy Tern.

Hume did not obtain specimens but said he had examined them from the Bay of Bengal, and knew of one having been shot at Port Blair. This record is omitted in the SYNOPSIS which quotes the FAUNA (**6** : 147) as giving 3 records from the Bay of Bengal—Calcutta ; near the mouth of the Ganges in the Bay of Bengal ; and Minicoy. The last is in the Maldive Islands, not in the Bay of Bengal as indicated in the SYNOPSIS. This species breeds in the Chagos Islands further south (*Ibis*, 1962 : 71).

*500. **Treron pompadora chloroptera** Blyth (Nicobars) Pompadour or Greyfronted Green Pigeon.

1 ♂ Car Nicobar : wing 175 mm.

***Treron pompadora andamanica** (Richmond) (MacPherson Strait, South Andamans) Pompadour or Greyfronted Green Pigeon.

1 ♀ Port Blair, S.A., 9 November 1963 ; 2♂♂, 2 ♀♀ Wrightmyo, S.A. : ♂♂ wings 177, 163 mm. ; ♀♀ 177, 178, 169 mm.

This bird is as large as the Indian Green Pigeon and looks very much like it in the field. It was quite common in most places in South and Middle Andamans, often in parties of 6 to 10. They feed on the

buds and fruits of forest trees, one pair having their crops so tightly packed with the green and ripe fruit of *Ficus infectoria* that they burst when the birds fell to the ground spoiling the skins!

Davison (1874 : 360) saw them building in May and surmised that they bred thereafter. A male taken on 23rd February had enlarged gonads, while a female on the same date appeared to have laid. Another on 28th February had a greatly developed egg in the ovary, and one shot on 3rd March also had developing ovaries. As in most pigeons and doves, the breeding season is probably spread over a long period.

Richmond (1903 : 308) described *Osmotreron chloroptera andamanica* from MacPherson Strait, South Andamans, as similar to *chloroptera* Blyth from Nicobars, but rather smaller, colour somewhat darker above and below; breast and sides deeper yellowish green, and undertail coverts more yellowish, the throat yellower than in *O. chloroptera,* and

Wing	165-168	as against	170·5-175 in *chloroptera.*
Tail	91- 98	,, ,,	98- 99 ,, ,,

Stuart Baker (5 : 189) stated that he could not separate *andamanica* of Richmond 'as in a large series his distinguishing characters prove to be individual'. He does not repeat these characters but Hume (1874 : 258) had drawn attention to the fact that the Nicobar birds 'invariably had less yellow on the outer margin of the secondaries (and generally though not invariably on those of their greater coverts)'. My specimens from the Andamans have two distinct yellow bars across the wing coverts in both the sexes, while the single specimen from the Nicobars has only one. I can see none of the other differences in size or colour, but this character appears distinctive enough to recognize an Andaman race.

***Ducula aenea andamanica** Abdulali (Betapur, M.A.) Andaman Green Imperial Pigeon.

1 ♂ Port Blair, S.A., 14 Nov. 1963 ; 2 ♂♂, 2 ♀♀ Wrightmyo, S.A.; 2 ♂♂, 2 ♀♀ Betapur, M.A.

After this race had been described by me (1964), Mr. W. W. A. Phillips examined the large series available in the British Museum and confirms that the differences mentioned by me justify the recognition of a new race.

This fine pigeon appears common throughout the Andamans. Its loud *qoo* and sometimes a more guttural *qroo* is uttered once, twice, or thrice. I am also fairly certain that this species is responsible for a deep *whoom,* often in answer to one calling *gr—groo* the first *gr* resembling the beginning of a hiccup. I also noted a *gr—ghoom.* It is possible that one or other of these calls is uttered by the Andaman Wood Pigeon, whose call I was unable to record separately.

Compared to smaller pigeons, the flight appears slow and flapping, but they keep high and many shots were fired at birds out of range. Many collect on trees in fruit and the lower mandibles are curiously expansible and so permit the swallowing of extraordinarily large fruit. This expansibility was also noted while handling wounded birds in Chanda District, Maharashtra, but does not appear to have been referred to earlier.

The food included large yellow flowers of an unidentified tree and its fruit, the fruit of *Sideroxylon longepetiolatum*, *Myristica andamanica*, *Calamus pseudorivalis*, and *Ficus infectoria*.

On 24th February at Betapur, where the forest in places was a little lower and the pigeons more accessible, I twice saw a most extraordinary sight—birds rising from trees suddenly stopped in mid-air and dropped 15-20 feet on half-closed wings and with the neck drawn back. They then pulled up again, the whole performance being very like the display flight of the Blackbellied Finch-Lark (*Eremopterix grisea*) but creating a most grotesque appearance. Sálim Ali (*J. Bombay nat. Hist. Soc.* **39** : 338) has referred to aerobatics of a similar nature by the Imperial Pigeon (*Ducula badia*) in Travancore, which aerobatics he likens to those of the Roller (*Coracias*).

Some 20 birds of this species were handled during February and except for two or three all had enlarged gonads, one containing an unshelled egg. Osmaston (1906a : 488) found a nest with a single hard-set egg on 10 April.

*508. **Ducula aenea nicobarica** (Pelzeln) (Nicobars) Nicobar Green Imperial Pigeon.

3 ♂♂ Car Nicobar, 7-10 March 1964

This is larger than the Andaman bird, the upper plumage being darker and bluer and showing very little green. The undertail coverts are dingy brown and not bright chestnut. The tail appeared longer in life. The grey of the head and breast is uniform and not tinged vinaceous and there is no sharply defined white forehead and chin as in the Andaman bird.

The calls noted were: (1) a deeper and longer *ghoom* than in *andamanica* and (2) a *koo-o* followed by a *kukku kukku-kukku*, more like an owl than a pigeon. This call was not heard in the Andamans.

Car Nicobar males had wings 252-255, avg. 254; tails 160-166, avg. 162.

A female shot on 7th March had 2 ova slightly enlarged 3 mm. × 3 mm.

Richmond (1903 : 308) quotes Abbott & Kloss regarding their extraordinary tameness on Tillangchong and Trinkut: ‘They with the

megapodes formed our staple diet in the Nicobars, until we loathed the sight of them'.

509. **Ducula bicolor** (Scopoli) (New Guinea) Pied Imperial Pigeon.

Hume and Davison (1874 : 264) found this pigeon common in many of the Nicobar Islands and also a seasonal visitor to Great Coco, Barren, and Narcondam Islands. Davison noted that they preferred the mangrove swamps to the thick forests and Butler (1899 : 688) saw them in large flocks of fifty or sixty. While the black and white plumage showed up in flight, he said that they were extremely difficult to see in the 'shifting lights of a thickly-leaven tree'. He said the note was a chuckling *ku ku ku*.

Osmaston (1906a : 489) found it common and breeding on North Sentinel Island, 17 miles off South Andamans, and also common in Narcondam. It is said to be patchily distributed, being found on small islands, occurring in some places in almost incredible numbers. Kloss (1903 : 156) found it common in the Great Nicobar, while Richmond (1903 : 309) referred to one specimen each from Camorta, Trinkut, Little and Car Nicobar, and quoted Abbott & Kloss that 'it is less common than *C. insularis* (*nicobarica*) in the northern islands but plentiful in the southern. At Little Nicobar large numbers used to roost on the islets of Trak and Treis, 6 or 7 miles distance, and fly over every morning to Little Nicobar'. It is also reported as seen at Barren Island, but I did not see it anywhere.

[**Columba livia** subsp. The Blue Rock Pigeon.

Boden Kloss (1903) refers to their being introduced into Car Nicobar in 1898 and seeing 'numbers in the vicinity of the bungalow in 1900'. I did not notice it during my short visit and it may not have established itself.]

*525. **Columba palumboides** (Hume) (Port Mouat, Andamans) Andaman Wood Pigeon.

1 ♀ Bambooflats, S.A., 9 Nov. 1963 ; 1 o? Bakultala, M.A. ; 1 ♀ Betapur, M.A. ; 1 ♂ Long Island, M.A.

This is larger than the Imperial Green Pigeon, but the great height of the forest trees, together with the similarly coloured underparts, usually prevents discrimination. I got the impression that occasionally this species descends nearer to the ground than the other, a fact confirmed by Davison and Butler. The call is a deep *whoom* without the preliminary *gr* of *Ducula*. One crop held the fruit of *Leae* sp. and another the ripe fruit of *Syzygium cumini*. At Betapur, Middle Andamans (23rd February), they were often seen in pairs.

Hume (1874 : 266) referred to the possibility of another fruit pigeon, 'large whitish, something like *bicolor*, but greyer and with a large red

naked space round the eye ', reported to him. This was later (*Stray Feathers* **3**: 337) identified as the adult male of this species. The specimens collected by me are very different in colour from the plate in Stuart Baker's INDIAN PIGEONS AND DOVES, showing none or very little of the purple gloss on the upper parts, nor as pale a head. Stuart Baker thought that adult females were identical. Another plate accompanying Walden's note (1873) on Ramsay's collections from the Andamans appears more representative. This incidentally is marked *Janthaena columboides*, while the text on the opposite page refers to *I. palumboides*! Later Walden (1874a : 157) separated the Nicobar birds (from Trinkut and Nancowry) as *I. nicobarica* distinguishing it from the Andaman bird chiefly by its wanting the pearly-white or greyish-white head, throat, and nape. Later authors have ignored this separation.

*527. **Macropygia rufipennis** Blyth (Southern Nicobars) Andaman Cuckoo-Dove.

2 ♂♂ Bakultala and Betapur, M.A.

Several were seen in heavy forest. One shot 25 feet up on creepers on a tree contained fruit of *Vitis* sp., and another had eaten the fruit of *Leae* sp. The second was a male with enlarged testes (24th February).

Hume (1874 : 266) held that they varied *inter se* to an incredible extent and described two main types. He also said that they fed largely on the small Nepal or bird's-eye chilli. Boden Kloss (1903 : 111) noted that the crops of all those shot on Kochal, Nicobars, were filled with large red chillies, and adds that their flesh tasted normal. Butler (1899 : 690) said he examined four stomachs but found no chillies. Osmaston (1906a : 489) said its call was peculiar, somewhat resembling that of *Cuculus canorus*, the Common Cuckoo. It is found in both the Andamans and the Nicobars.

* 536. **Streptopelia tranquebarica humilis** (Temminck) (Bengal and Luzon) Red Turtle Dove.

1 ♂ Wrightmyo, S. A.; 2 ♀♀ Ferrarganj, S. A.; 1 ♀ Bakultala, M. A.; 1 ♀ Long Island, M.A.

At Port Blair they were common and courting (10th February), the male bobbing up and down to the female at the top of a high tree. A male with well-developed testes shot at Betapur had been feeding on rice, and the bird was frequently noted in and near cultivated land, i.e. paddy. In November, I saw them in parties of 10 to 12 and again noted 20 to 25 birds collected on the tops of trees, just before sunset. They then all flew off in the same direction, no doubt to roost.

Davison found it exceedingly rare, but Butler said it was quite common and he saw scores collected together in a field. Osmaston (1906a : 489) found it extremely common around Port Blair and

noted that it had apparently multiplied since Hume's time (1873) with the increase of the area under cultivation. He found them breeding in April and May.

The five specimens obtained (1♂ and 4 ♀♀) have their wings 142 mm. in the male and 136-142, avg. 138·2, in the females. All the birds are in varying stages of plumage, and include a female in full male plumage. The Society's collection includes two others, from Bolandshar, U.P., Reg. No. 13050, and Prome, Burma, No. 13056, in male plumage but marked females. The Andaman birds appear nearest to *humilis* but though specimens were borrowed from the Zoological Surveys of both India and Pakistan, it has not been possible to satisfactorily sort out the races or plumages of this species.

[539. **Streptopelia chinensis tigrina** (Temminck) (Java) Spotted Dove.

Blyth received a specimen brought by Capt. Lewis from the Nicobars. Again in 1863 (Appendix) he says: 'On the Nicobar, *Turtur tigrinus* (Temminck) exists, similar to the race inhabiting Burma and Malaysia . . . .'. Though Hume referred to this single record, Butler later suggested that it be dropped and I agree with him.]

541. **Streptopelia senegalensis cambayensis** (Gmelin) (Gulf of Cambay) Little Brown Dove.

Butler found it not uncommon at Port Blair but, as earlier observers had not recorded it, suggested that it may have been introduced later. Osmaston (1906a : 489) failed to see it, and I did not see it either. Ripley (SYNOPSIS) includes the Andamans in its distribution.

542. **Chalcophaps indica indica** (Linnaeus) (Amboina) Emerald Dove.

Dr. Dillon Ripley, to whom I sent the Andaman specimens, compared them with skins from the Nicobars available to him and informed me that the latter were identical with *indica*. The Nicobar birds have earlier been separated as *C. augusta* Bp. (*Comptes Rendus* 1855).

*544. **Chalcophaps indica maxima** Hartert (Golapabung, South Andamans) Emerald Dove.

1 ♂, 1 ♀ Mannarghat, S.A.; ♂ Bakultala, M.A.

Hume found it extremely numerous. I saw a few specimens both in the Andamans and on Car Nicobar but, as in India, the bird lives in heavy cover and is difficult to secure at the right range—more than one was too badly damaged to preserve. I shot a ♂ with enlarged testes and a female with a granular ovary on 16th February. The organs of a male taken on 18th February were undeveloped. Osmaston (1906a : 489) took a single fresh egg on 29th May. This species, as in

many pigeons and doves, probably has an extensive breeding season.

* **Calaenas nicobarica** (Linnaeus) (Nicobars) Nicobar Pigeon.

1 ♂ Mannarghat, S.A.

This is omitted in Ripley's SYNOPSIS. The FAUNA (**5** : 214) gives the distribution thus : 'The Cocos, Andamans and Nicobars, throughout the islands of the Malay Archipelago to the Solomon Islands. It has not yet been found on any of the islands of the Timor group.' Blyth (1846b : 371) and Pollok (1879, **2** : 16) refer to its occurrence in the Cocos.

This species breeds in thousands on Battye Malve in the Nicobars and in lesser numbers on some of the other islands. Osmaston found nests on South Sentinel Island off Little Andaman. It is a straggler into the main Andamans, but Osmaston (1906a : 489) said it was not as rare as was generally believed as it frequents thick forest and is not easy to see. The only bird I met came off the ground in heavy undergrowth in evergreen forest on a hillside. It rose with a lot of fluster, like a junglefowl, and when winged walked rapidly through the undergrowth (Butler noted that when walking it carried its wings much lower than an Emerald Dove did, and sometimes so low as to suggest some injury at the shoulder). Water dripped out from its bill, suggesting that it had drunk (10 a.m.), probably at a stream 30 yards away.

The gullet had 4 or 5 seeds of *Sideroxylon longepetiolatum*, which had obviously been picked off the forest floor and were without any fleshy fruit. The stomach had peculiar hardened patches on opposite sides, which presumably permitted this species to crush and digest seeds which would not be edible by the other pigeons (For description of stomach, see Flower, *Proc. zool. Soc.* 1860 : 330). Butler (loc. cit.) took quantities of small seed from the crops of birds shot on Car Nicobar. It was of two kinds, one rather like a prune stone, so hard as to be almost unbreakable, and the other much resembling a sunflower seed.

The bird was a ♂ with slightly enlarged testes. The wing measured 240 mm. against the FAUNA measurements of 247-268 mm. It is a common cage bird and breeds well in captivity.

*548. **Psittacula eupatria magnirostris** (Ball) (Andaman Islands) Large Indian, or Alexandrine, Parakeet.

1 ♂ Wrightmyo, S.A. ; 1 ♂, 1 ♀ Ferrarganj, S. A.

This is quite common in South and Middle Andamans. A male and a female were shot out of a large party of 30 to 40 birds in a tree; the former was in breeding condition, but the latter not. At Long Island on 27th February, 2 pairs were seen attending holes in a tall *gurjan*. Osmaston (1908 : 358) noted it on Barren Island.

Hume said their note was quite different from that of other species in the Andamans and that they roosted in mangroves at the entrance to a creek. Osmaston (*J. Bombay nat. Hist. Soc.* **17** : 240) has an interesting note on patches of mangrove (*Rhizophora mucronata*) an acre or so in extent, in which all the mangroves are apparently dead at the top or ' stag-headed '. Various explanations, including the slow subsidence of the Andamans were put forward, but Osmaston discovered that it was caused by large numbers of this and the Redbreasted Parakeets collecting to roost there ! The bills of the males are heavier and the red patch on the wings is a brighter red than in Indian birds. The bills of the females do not show the same difference.

[**Psittacula krameri** was introduced by Col. Tytler (*c*. 1863) but had disappeared by the time of Hume's visit in 1873.]

*552. **Psittacula alexandri abbotti** (Oberholser) (South Andaman Island) Redbreasted Parakeet.

1♂, 1 o? Wrightmyo, S. A. ; 1♂ Bakultala, M. A. ; 1♂ Long Island, M.A. ; 1♂ Bambooflats, S. A., 17 March 1964.

Common in South and Middle Andamans. Often seen in Port Blair and in fields and open country.

The flight is slow and the rounded wings noticeable. The call was a plaintive but distinctive *kewn*, while a female was heard to utter a nasal *kaink*.

Kloss (in Richmond 1903 : 303) said it was common in large flocks and did extensive damage to paddy. Osmaston (1906a : 487) stated it came to Port Blair in tens of thousands in December and January, devouring the paddy.

553. **Psittacula caniceps** (Blyth) (Nicobars) Blyth's Nicobar Parakeet.

This large parakeet has been recorded only from the islands of Montschall, Kondul, and the Great Nicobars. Davison said that it keeps to the top of the higher trees. The call is a wild screeching note which it utters both when seated and in flight. It feeds much on the ripe fruit of the pandanus, so abundant on the inhabited islands. It is very popular as a pet bird and numbers are caught for sale. I only saw one in a cage at Port Blair, large but dingy to look at.

*555. **Psittacula longicauda tytleri** (Hume) (Andamans) Redcheeked Parakeet.

1♂, 1♀ Wrightmyo, S. A. ; 1♂, 1♀ Bakultala, M. A. ; 1♀ Long Island, M. A.

This parakeet was common in most places in South and Middle Andamans, and has been recorded from Barren Island, Narcondam, the Cocos, and Preparis. Butler saw them in vast flocks of thousands

about the fields of ripe paddy. He also refers to an officer telling him of an entirely light-blue bird seen with a large flock of this species.

Osmaston (1906a : 487) took 2 fresh eggs on 20th February.

*556. **Psittacula longicauda nicobarica** (Gould) (Nicobar Islands) Redcheeked Parakeet.

1♀ Car Nicobar.

This is the Nicobar form of the last species. Hume said it fed largely on papaya, ripe pandanus, and the covering of betel nuts (*Areca catechu*).

My specimen has a 191 mm. wing as against 167, 169, and 170 in the 3 females from the Andamans. In addition, the bill is heavier, the primaries bluer, and the underparts more yellow.

*566. **Loriculus vernalis vernalis** (Sparrman) (Cachar) Indian Lorikeet.

2 ♂♂ Maymyo, S. A.; 1♂ Wrightmyo, S. A.; 1 ♂ Bambooflats, S. A.; 1♂, 1♀ Bakultala, M.A.; 1 ♂ Long Island, M.A.

The lorikeet was common everywhere in South and Middle Andaman. Hume and Davison did not see it in the Nicobars, but referred to a Mr. Wood-Mason seeing one on Great Nicobar. Abbott & Kloss (Richmond 1903) report it 'everywhere in the Nicobars' but secured no specimen. It is omitted from the Nicobars in the SYNOPSIS.

Davison took 3 eggs on 19th April and said there was no lining to the nest. On 15th February I saw 2 newly-hatched young at the bottom of a hole in a vertical stump 3 inches thick and about 10 ft. from the ground. The hole was at the top and the nest 2 ft. lower, was lined with green leaves. The tree stood on the edge of the forest, within a yard of the tidal mark.

Butler (*J. Bombay nat. Hist. Soc.* **11** : 736) confirmed that the nests were lined with leaves and added that the birds sat close and when disturbed on their eggs uttered a long-drawn querulous note like *chee-ee*.

Osmaston (1906a : 487) found nests at the bottom of holes in stumps, 'the eggs being usually below the level of the ground'.

Several were noted on the flowers of *Erythrina* sp.

In *J. Bombay nat. Hist. Soc.* **37** : 754, Whistler doubted if *rubropygialis* could be separated from typical *vernalis* and later (loc. cit. **44** : 12) confirmed that it could not. The race *rubropygialis* is retained by Ripley (SYNOPSIS : 173) but I cannot agree after an examination of twenty-seven specimens.

The blue on the throat appears in males only, showing in 2 (and slightly in a third) out of 5 from the Andamans, in 7 out of 8 from western and southern India, and in 4 out of 8 from the North-east and Orissa. Of the 25 sexed skins only 5 were of females.

Three specimens from Burma are slightly smaller (wing 85-90, avg. 87) than the others (FAUNA 87-97, avg. 93), while their upper plumage is slightly yellower.

* **Cuculus micropterus** subsp. Indian Cuckoo.

Ball (1872 : 280) records one and Walden (1873 : 304) identifies 4 specimens by Ramsay as of this species. In *Stray Feathers* 3 : 264, Hume refers to a true *Cuculus micropterus* killed in the Andamans by Mr. A. de Roepstorff. Osmaston (1906a : 487) found them common and noisy from April to June. These records are omitted in the SYNOPSIS.

I heard the *cross-word-puzzle* call at all camps between 11th February and 6th March, but did not obtain any specimens.

Cuculus canorus subsp. Cuckoo.

Hume (1876 : 288) states that he received one killed in the Andamans on 16th November. This has been ignored in both the FAUNAS, and in the SYNOPSIS.

580. **Cuculus saturatus saturatus** Blyth (Nepal) Himalayan Cuckoo.

Hume (1874 : 83 and 190) saw and heard it in the Andamans and Nicobars and obtained two specimens on Kondal. Butler says it is not uncommon in both groups during the summer months.

581. **Cuculus poliocephalus poliocephalus** Latham (India) Small Cuckoo.

In the SYNOPSIS the Andamans are included in the range of this species.

586. **Chalcites maculatus** (Gmelin) (Ceylon) Emerald Cuckoo.

Blanford (FAUNA **3** : 223) says it is found in the Andamans and Nicobars, but the whole area is omitted by Stuart Baker, and in the SYNOPSIS.

587. **Chalcites xanthorhynchus xanthorhynchus** (Horsfield) (Java) Violet Cuckoo.

Hume (1874 : 191) refers to a specimen near Port Blair in wet tropical evergreen forest in mid-August, and Walden (1874c : 136) to birds obtained on 5th May and 14th and 23rd July, including an immature one.

I did not see any and the dates suggest a monsoon visitor.

The SYNOPSIS records it from the Andamans and Nicobars, in addition to Assam.

[**Surniculus lugubris** subsp. Drongo-Cuckoo.

Kloss (in Richmond 1903 : 302) says he shot and lost a bird apparently of this species on Katchal Island. It is rightly omitted in later works, but it is noticeable that no small drongo is known from the Nicobars.]

*592. **Eudynamys scolopacea dolosa** Ripley (Barren Is., Andamans) Koel.

1 ♀ (by plumage), Port Blair, 19 February : wing 211 ; tail 200.

I saw and heard this bird at Port Blair and Betapur, Middle Andamans. The calls were identical with those of Indian birds.

Kloss (in Richmond 1903 : 302) found it very common in the Nicobars and often saw a female koel pursued by a grackle, both in a very excited state, shrieking and screaming with rage. This prompted him to suggest that the koel parasitises the grackle and also the Imperial Pigeon (*Carpophaga*), as the koels could be called up by imitating the deep hoarse *coo* of the pigeon. Osmaston (1906a : 487) said it was a migrant to the Andamans, arriving in September-October, leaving in April and not breeding there. He also noted it on Barren Island (1908 : 358) during a one-day trip and described it as a cold weather visitor.

The single specimen which was obtained by Mr. Young is in female plumage. The 211 mm. wing is longer than in any of either sex from India. The upper parts are blacker and with distinct rufous dots; the rufous wash, visible in the field, extends over all the white parts including chin, lower belly, and subcaudals. Ripley has described this race from the Andamans and Nicobars allowing the very abnormal range in wing size (198-227·5 mm.) as offset by the wing-tail index of 91. In this specimen it is 94·7 !

*603. **Centropus (sinensis) andamanensis** Beavan (Andaman Islands) Crow-Pheasant.

2 ♀♀ Wimberleyganj, S. A. ; 1 ♂, 1 ♀ Wrightmyo, S. A. ; 1 ♀ Long Island, M. A.

This Crow-Pheasant was often seen or heard in most camps in South and Middle Andamans and also at Port Blair, usually among trees and also in mangrove swamps.

They often called for quite some time after dark and very early in the morning. Long spells were heard at night. There were 20 to 22 hoots at a time ; the call sometimes ended in a complaining tone.

Butler said they were partial to frogs, which were killed and swallowed. Hume also noted this bird on Great and Little Coco and the Table Islands. On Kondal (Nicobars) and also on Jolly Boys Island, South Andamans, he saw a larger bird of the *rufipennis* (*sinensis*) type. There is some variation in the intensity of the colours of the wing,

head, and back, and I must confess that I saw several birds which looked different in size and colour. All the specimens, however, are of this form.

A male (16th February) and a female (12th February) had enlarged gonads.

Hume speaks of eggs taken by Capt. Wimberley in June. He also refers to traces of barring on some specimens, apparently young (see Abdulali 1956, *J. Bombay nat. Hist. Soc.* **54** : 183). Osmaston (1906a : 487) took eggs in July.

607. **Tyto alba deroepstorffi** (Anonymous = Hume) (Aberdeen, South Andamans) Barn Owl.

Hume (1875 : 390) described this from a single bird obtained by de Roepstorff at Aberdeen, South Andamans, and Osmaston caught one in a field. Butler (1900 : 568) saw 2 skins in the Indian Museum and also obtained one himself. The note, he said, was the usual barn-owl screech and the pellets he found indicated that the food consisted entirely of rats and mice.

*613. **Otus balli** (Hume) (South Andaman Island) Andaman Scops Owl.

1 ♀ Wrightmyo, S.A.

The only bird which I met a little after sunset was perched on a roadside stump, a couple of feet off the ground on the edge of open cultivated land. The shot blew off the ends of both wings and also half the tail, preventing any examination of the relative lengths of the several primaries, and I assume that it is not *Otus scops* as the tarsus is not fully feathered and the plumage does not agree with that of any of this species available for examination.

Butler (1899 : 570) found it very common in the Andamans, but said that because of its small size and nocturnal habits it was very difficult to procure. He said its note resembles the syllables *hoot*! *hoot-cooroo*! jerked out very rapidly, the rolling '*r*' in the last note being very distinct. He added that it was identical with the call of the Ceylonese Scops Owl and that it also had a low chuckling note. It fed, to a considerable extent on caterpillars, in searching for which 'it slides up and down the boughs of small trees in a very parrot-like manner'. Two of his specimens were captured in bungalows, and he thought that a female shot in May had 'just incubated'.

Osmaston also noted it as common (1906a : 487) and eggs were taken by him and Wickham between 20th February and 14th April (NIDIFICATION **3** : 521).

It does not appear to have been recorded from the Nicobars.

Otus scops modestus (Walden) (Andamans) Burmese (?) Scops Owl.

Various owlets were recorded from the Andamans and Nicobars —*Ephialtes spilocephalus* by Blyth, a ' *Scops* of *pennatus* type ' by Ball, *E. lempigi* by Tytler. Walden described *modestus* as a new form from the Andamans (' distinguishable from all the other described Asiatic species by its sober colours and plain markings and, with the exception of *Scops mantis*, by its diminutive size '). Hume (1876 : 283) described *nicobarica* from Camorta as " resembling *sunia* with whole forehead, crown, occiput, and upper parts generally, together with the head, throat, and breast ferruginous chestnut, much more than *sunia* ever is . . . . the vermiculations and the markings on the upper surface are coarser and more sparse than in rufous *pennatus*." Blanford (FAUNA **3** : 296) said that *modestus* was a young *balli* but it was accepted as a race of *Otus sunia* by Stuart Baker (FAUNA **4** : 437) as found in Assam south of the Brahmaputra, Burma south to Tenasserim, etc., Andamans and Nicobars. Ripley in the SYNOPSIS has omitted the race *modestus* (and *nicobarica*), excluded the species from both the Andamans and the Nicobars, and accepted *O. s. sunia* for Burma.

It appears evident that some form of Scops Owl, other than *balli*, exists in the Nicobars, and probably in the Andamans too.

*645. **Ninox scutulata obscura** Hume (Camorta, Nicobars) Brown Hawk-Owl.

2 ♂♂, 1 ♀ Mannarghat, S. A.: wings 215, 212, 200; tails 123, 115, 120.

At Mannarghat it appeared to be quite common in a rubber plantation, on the edge of heavier forest, commencing to call in loud disyllablic *coo-ook*s at sunset from relatively exposed perches either on dry branches or at the top of a tree. I found the 2 males I shot by their calls, and the female which was shot by the bush-policeman was said to have been similarly traced. It was also heard at Bakultala, M.A.

One of the males and the female had enlarged gonads though not yet in breeding condition.

Butler (1899 : 684) said it was extremely common in the Andamans and that he had heard as many as a dozen hooting at the same time on fine still nights. He described the calls as a low *whoo-wuk* or *coo-whoop*, a soft clear flute-like sound, and stressed the fact that it was more like that of *scutulata* than of *affinis*.

Richmond (1903 : 304) measured a male from Car Nicobar as having a 206 mm. wing and a female from Katchal 203 mm. The male is smaller than the two from South Andamans (215, 212 mm.). The Andaman male with undeveloped testes is paler brown on the undersurface than the other two.

The stomachs of the birds mentioned by Richmond contained beetles, which Butler also said was their principal food. The birds I collected contained grasshoppers.

646. **Ninox affinis affinis** Beavan (Aberdeen Point, Port Blair, South Andaman Island) Brown Hawk-Owl.

In the Appendix to Blanford's FAUNA (**4** : 485), the call is described as a loud *craw*, something like a *Glaucidium* note. Earlier (**3** : 311) Capt. Legge said it was a not unmelodious hoot *whoo-uk*. This agrees with my version of *obscura* and was in all probability a mistake.

Davison saw it hawking small moths (1874 : 153).

Butler (1899 : 571) said it fed on moths and beetles.

At Long Island, an owl called from the jungle *kra-aunk* . . . . , . . . *kra-aunk* . . . . *kuk*, *kra-aunk* every 3 or 4 seconds sometimes with, but usually without, a preliminary *kuk*. It appeared to be very common but I could not get one and must leave its identity doubtful.

647. **Ninox affinis isolata** Baker (Car Nicobar) Brown Hawk-Owl.

Butler (1899 : 571) did not hear it during a short visit and thought it was less common than in the Andamans.

[**Strix selaputo** Horsfield = *S. orientalis* Shaw Malayan Wood Owl.

Blyth (1846 : 369) referred to a specimen obtained by Capt. Lewis in the Nicobars but not preserved, which he (Capt. Lewis) later identified with a skin from Malaya. A large owl was noted by Tytler (1867 : 316).

Butler (1899 : 568) also said that ' a *Syrnium* of sorts does occur in the Andamans ', and he heard its typical *to-whoo*.

He also refers to a large horned owl (*Ketupa* ? *javanensis*) which was seen and shot by others in desolate mangrove swamps bordering the salt-water creeks. Neither of the owls is mentioned in the FAUNA or SYNOPSIS, but their occurrence must be looked for.]

*679. **Caprimulgus macrurus andamanicus** Hume (Jolly Boys Island, South Andamans) Longtailed Nightjar.

2 ♂♂ Port Blair, S.A., and Long Island, M.A.: wing 179 & 184; tail 118 & 128.

2 ♀♀ Wrightmyo, S. A., and Betapur, M.A.: wing 182 & 174; tail 117 & 129.

This nightjar was seen or heard at all camps in South and Middle Andamans. It was seen in mangrove at the mouth of a creek at sunset, and also seen flighting out daily from a heavily forested hillside to a mangrove swamp.

The call is a typical nightjar *chuk-chuk-chuk* often preceded by a *kwak*. Butler describes it as a liquid monosyllabic *clook* ! *clook* ! They

spend the day, usually in pairs, among the leaves on the forest floor.

A male shot on 25 February had slightly developed testes. Davison obtained 2 eggs on 12 April. Osmaston (1906a : 487) found a slightly incubated egg on 9 April and two half-fledged young on 4 May.

Wickham (*J. Bombay nat. Hist. Soc.* **19** : 993) took 2 fresh eggs on 4th February and found another two about a yard away on 25th February. He goes on to cite another instance of 2 eggs taken on 6th and 30th March at another place, under the same circumstances.

Hume (1873 : 162) states that several persons, who landed on Southern Jolly Boys Island, saw a huge nightjar which was 'certainly *Lyncornis*'. At two camps I saw birds hawking at dusk, which I would have noted as large nightjars had I not been able to approach nearer and determine that they were Broadbilled Rollers (*Eurystomus*)!

683. **Collocalia brevirostris brevirostris** (McClelland) (Assam) Plain-rumped Himalayan Swiftlet.

I am unable to trace the authority for the statement in Ripley's SYNOPSIS that this is an 'uncommon winter visitor to the Andamans'. There also appears to be no evidence that this species makes an edible nest and, as it cannot be called the Indian Edible-nest Swiftlet, I adopt the names used by Stuart Baker in NIDIFICATION for the two races.

684. **Collocalia brevirostris innominata** Hume (Andaman Islands) Striperumped Swiftlet.

The type specimen obtained at Port Mouat in South Andamans appears to be the only record from this area, where it can only be a winter straggler. It occurs in the Hupeh Province in Central China.

*686. **Collocalia fuciphaga inexpectata** Hume (Andaman Islands) Greyrumped Swiftlet.

2 ♂♂ Wrightmyo and Long Island : wing 116, 116.
2 ♀♀ Wrightmyo and Long Island : wing 115, 113.

At all camps in South and Middle Andamans, and also on Car Nicobar, small parties were frequently seen hawking over rice, rubber, mangrove, and other wooded portions not too high. At Wrightmyo parties were seen flying seawards in the evenings, no doubt to roost.

This species make the pure translucent white nests which go to make the famous soup. Osmaston (1906a : 486) saw colonies in caves by the shore in several places. On the sea-shore at Mandapahar, Chiria Tapoo, South Andamans, was a small cave 15 yards × 15 yards × 4 ft. high in which I obtained 3 empty nests, while the walls bore traces of other nests having been removed. Large numbers of swiftlets flying

outside were white-breasted birds that had their nests in another cave about 200 yards away. We left this place at 4-30 p.m. and must assume that the birds came in to roost later. They were certainly seen hawking over creeks and other places far from caves, much later.

Hume took eggs in a cave on Little Button Island on 21st March. I found an empty nest in a rock crevice on the same island on 29th February, and saw the birds hawking outside, but the nest was dark in colour except for a paler and thicker rim.

On 22nd February as I watched a party hawking over mangrove, I saw one bird go round in small circles, with tail expanded, and quivering wings raised 45° above the level of the body. A swallow (*Hirundo rustica*) appeared to be the only other bird interested in the performance.

*687. **Collocalia esculenta affinis** Beavan (Port Blair, South Andaman) White-breasted Swiftlet.

1♂, 2♀♀ Chiria Tapoo, S.A.; 1 ♂ Wrightmyo, S. A.: wing 97-102, av. 98.7 mm.; tail 37-40, av. 38 mm.

This swiftlet is common in both the Andamans and the Nicobars. Tytler left notes made *c.* 1863 saying that they did not nest in houses, but a little later in 1873 Hume recorded that they nested freely in houses on both Ross and Chatham Islands (near Port Blair). I saw it around the Secretariat and at other places in Port Blair, and though I did not see any nests in houses there was every appearance of their still nesting there.

On 15th February at Mandapahar, Chiria Tapoo, South Andamans, I saw hundreds entering and leaving a cave on the seashore. The cave, in a 200 ft. rock-face, was 10 ft. high, 20 yards deep, and 15 yards wide. The tide entered the cave, but the innermost parts were bespattered with dung and a very peculiar smell prevailed. The walls were plastered with their very distinctive nests of moss glued together with saliva. Some nests touched each other and were stuck together. Many contained 2 eggs in an advanced state of incubation. Three specimens shot outside the other cave referred to under *C. f. inexpectata* had undeveloped gonads.

Butler saw them nesting in the Nicobars in August and September and at Port Blair in December and January. Osmaston (1906a: 486) said it bred in vast numbers at the Chatham Saw Mills, and their nests were not made of moss but of Casuarina leaves and coconut fibre, both of which were not indigenous to the Andamans. In the FAUNA (**4** : 352), Osmaston is quoted as saying that the nests were made of ' Casuarina leaves, seaweed and human hair, consolidated and matted together with saliva'. Hair was found used in the majority of nests. Stuart Baker

refers to some 'nests which are almost purely saliva; I have two such with just one or two fragments looking like moss incorporated'.

Ibis, 1892: 578, reproduces an account of nest-collecting in the Andamans from a recent issue of the *Englishman* of Calcutta. Reference is made to 3 species of *Collocalia* [*innominata*, *inexpectata*, and *linchi* (*esculenta*)] arriving in that area towards the end of November, before which parties are sent out to clear the caves of all the old nests. About the last week in January, the collectors go round the islands, a journey which takes about three weeks in an open boat. The best quality resembling pure isinglass and worth their weight in silver are found in limestone and volcanic rock, the nests built in sandstone and serpentine being inferior. All the nests are taken and the birds build faster, a second collection being made at the end of February, which is usually the best. A third is made in April, when the nests, though of good quality, are thin and dry . . . . The best quality realised Rs. 130 to Rs. 145 per viss and the third quality with feathers and other foreign material Rs. 90. It is admitted that it is not known which species makes which nest.

It is commonly accepted that after the first crop is taken, subsequent nests are less pure. It may therefore be worth while quoting from a recent letter from Lord Medway, to whom I had sent the skins and nests of the swifts for confirmation of my identification:

'I have never been able to see differences between first nests and replacement nests, in terms of structure or of composition of the material, apart from the fact that the first nests taken any season tend more often to include remnants of the previous season's structure.

'Among the nest collectors, there is a vast amount of very dubious lore related to the qualities and properties of the nests, which is in many cases without foundation. I am inclined to think that the business of first and second nests falls into this category.'

I saw the birds at Wrightmyo and, though I have an impression that I met it in the Middle Andamans, I cannot find this in my notes. It was frequent at Car Nicobar, and Abbott and Kloss (in Richmond, 1903: 301) took six specimens, all females, along the shore in Little Nicobar. Davison has some notes on their building and nesting (Hume 1874: 159) and refers to the remarkably small amount of space that a very large number of these birds will occupy: 'They all cluster together like a huge swarm of bees clinging to the bare boards of the roof in a wonderful manner'. Butler (1899: 564) refers to a curious habit: 'Often when one bird is clinging to the commencement of a nest, its mate flutters round unable to find a foothold. In this case, the sitting bird catches the other by the tips of the primaries and holds him suspended there for some little time. In a cluster of these birds at work building, I have sometimes seen three or four at the same time hanging down-

wards in this way, their mates holding them by the tips of their outspread wings.'

I have seen them drink at a pond at midday.

The upper parts of all the specimens show a distinctly greenish gloss as against deep bluish in a single skin from Fraser's Hill, Singapore, which is also larger (Wing 110, Tail 40).

*691. **Chaetura gigantea indica** Hume (Andamans and southern India) Large Brownthroated Spinetail Swift.

1 ♀ Long Island, M. A.: wing 189, tarsus bare below knee.

These birds appear to be less common than they were earlier. Hume said they were common about Port Blair, and Butler saw them throughout the year, noting scores assembling every evening round a bungalow on Mt. Harriet, where Osmaston (1906a : 486) also found them common. I saw small parties of what were probably these birds at Wrightmyo and Betapur, usually flying over a beat of several miles and returning the same way. They were usually high out of range and can apparently only be obtained when they come down to drink. At Betapur, a party of 10 to 15 was circling over the village, their tails sometimes expanded with the spines visible. One evening on Long Island, I secured one out of a pair circling over a freshwater pool, presumably to drink.

The feathers at the gape of the wounded bird appeared long and erectile—I wonder if this is an adaptation to increase the catching area (?).

Butler refers to some being infested by a large flat tick, nearly ⅓ of an inch in length. From one bird he took over 30 which were clinging in rows to the bases of the stiff tail feathers under the lower tail coverts. He added that winged birds uttered a shrill squeaking cry. Only one of the 15 birds he handled had the spot in front of the eye white, being mouse colour in the others. Davison (1873 : 473) said their presence high up in the air could be detected by their sharp, clear note frequently uttered on the wing.

696. **Apus apus pekinensis** (Swinhoe) (Pekin, China) Swift.

Ripley (SYNOPSIS) mentions this as a winter visitor to the Andamans, presumably referring to the single specimen shot by Capt. Wimberley on 30th July 1873 and referred to by Hume (1874 : 156) as *A. acuticauda* (Blyth).

Kloss (Richmond 1903 : 301) ' saw a large flock of swifts on Barren Island ' but gives no description.

Butler also saw a small white-rumped swift, which he calls *Cypselus subfurcatus* Blyth, hawking round the bungalow on Ross Island with a number of *Collocalia*.

723. **Alcedo atthis bengalensis** Gmelin (Bengal) Common Kingfisher.

I collected what I thought was this species at Long Island, but when working out the collection I found that it was *Alcedo meninting*. Birds seen on rocks on the seashore were almost certainly of this species. Davison said it occurred in both the Andamans and Nicobars, but was not common, and Butler confirmed that for every one of this species he saw at least three of *beavani* (*meninting*). Osmaston (1906a : 162) saw a few around Port Blair.

Hume thought that the birds from the Andamans and Nicobars had shorter bills and duller plumage than continental birds, but Richmond (1903 : 300) said these differences were not visible in 4 specimens from the Nicobars.

***Alcedo meninting rufigastra** (Walden) (South Andamans) Blue-eared Kingfisher.

2 ♂♂ Wrightmyo, S. A., and Long Island, M. A.: wing 68 (2); tail 29, 27; bill from feathers 38, 36.

In size, colour, and habits, this bird is very similar to the Common Kingfisher (*A. atthis*). One, flushed off a mangrove root in a tidal nulla bordered by *Rhizophora mucronata*, flew low over the water but travelled two such spurts of about 400 yards each before permitting a shot. The other was shot from a tree along the sea-shore. Butler said it was generally found on freshwater streams, while Davison noted it as exclusive to salt-water creeks. Osmaston (1906a : 162) found them common on both salt- and freshwater creeks, and nests, usually with 5 eggs, between 25th June and 15th July.

The two specimens are very similar to those from Assam and other parts of India, except that they have less purple on the nape and the sides of the head. This characteristic is first mentioned by Stuart Baker in the FAUNA (**4** : 257). In the SYNOPSIS this race is omitted, and the Andamans are omitted from the range of this species.

728. **Ceyx erithacus macrocarus** Oberholser (Great Nicobar) Three-toed Kingfisher.

The distribution of this race in both Stuart Baker's FAUNA and Ripley's SYNOPSIS reads : 'Andamans and Nicobars', but their status in the two groups is very different. From the Andamans there appear to be only three records—two of birds which flew into houses near Port Blair (Hume 1874 : 173 and Butler 1899 : 561), and the third (Osmaston 1906a : 162) of a bird excavating a nest hole in the bank of a small rocky stream in dense forest below Mt. Harriet on 27th May. In Great and Little Nicobar they were common, Abbott and Kloss obtaining 10 specimens.

Pelargopsis capensis shekarii Abdulali (Chiria Tapoo, South Andamans) Storkbilled Kingfisher.

2 ♀♀ Chiria Tapoo, S.A., and Long Island, M.A.

When I described this race (1964) I had only two specimens from the Andamans and two from Burma. Mr. W. W. A. Phillips has kindly looked at the material at the British Museum and informs me that the 7 specimens from the Andamans available there have, in series, paler heads and less blue on the upper wing coverts than in Burmese birds.

This bird was seen quite a few times in mangroves, along creeks, and on the sea-side, both in South and Middle Andamans. It uttered a loud *khà-u khà-u khà-u* 8 to 10 times and then flew off with a louder *khī-ok khī-ok*. Davison (Hume 1874 : 166) refers to a loud shrieking note uttered on the wing. Osmaston (1906a : 162) found it fairly common in brackish creeks, but did not obtain a nest.

732. **Pelargopsis capensis intermedia** Hume (Galatea Bay, Nicobars) Storkbilled Kingfisher.

Hume noted it on the seashore at Galatea Bay, Kondul, Pilu Milu, Montshall, and Little Nicobar. Abbott (in Richmond 1903) said it was common in Great and Little Nicobar, but did not see it on any of the other islands. His 5 specimens were all females.

*734. **Halcyon coromanda mizorhina** (Oberholser) (North Andaman Island) Ruddy Kingfisher.

Hume rightly stated that it was far from common and affected the gloom of the mangrove swamps. I got glimpses of it on four occasions on South and Middle Andamans, but could not get a shot. The colour of the bird resembles that of the dry leaf of the mangrove *Rhizophora mucronata.*

*738. **Halcyon smyrnensis saturatior** Hume (Andaman Islands) White-breasted Kingfisher.

1 ♂ Ferrarganj, S.A.; 2 ♀♀ Wimberleyganj, S.A., and Long Island, M.A.

This kingfisher was one of the commonest birds in South and Middle Andamans, being both near and far from water. On a 30-mile drive I counted 65 birds, no doubt missing many on the other side of the road. The white patches on the wing are more conspicuous than in Indian birds, and were particularly prominent when a bird perched near another opened its wings in some form of courtship. During the course of the day I saw this being done on several occasions. A bird was seen to settle on a rock with a large crab. With much effort the legs were battered off, then the carapace was folded over but was still too large to be swallowed !

Butler (1899 : 562) states that he has sometimes seen it hover over

water for some seconds, like *Ceryle rudis*, and then dart obliquely into the water and catch a fish. Osmaston (1906a : 162) found it breeding in holes 2 to 3 feet deep, in April and May.

The 3 specimens are very distinctly darker brown on the head and underparts than any from India. They show among themselves as much variation in the blue of the upper parts as the 3 races said to exist in India, *smyrnensis* (Linnaeus), *fusca* (Boddaert), and *perpulchra* Madarasz. 56 specimens are available in Bombay, but I cannot separate them by colour. I have not measured them.

*739. **Halcyon pileata** (Boddaert) (China) Blackcapped Kingfisher.

Tytler said it was common in the Andamans, but Hume and Davison found it rare in both the Andamans and Nicobars, and failed to secure specimens. Capt. Wimberley obtained a pair near Port Blair. Osmaston (1906a : 163) saw it thrice (Port Blair, Cinque Is., and Narcondam) in fifteen months.

I saw it twice at Betapur, flying low over the creek, but did not get a specimen.

Abbott (Richmond 1903 : 301) saw it on Barren Island, and met it on all the Nicobars, finding it particularly numerous along Galatea River in Great Nicobar.

*742. **Halcyon chloris davisoni** Sharpe (Aberdeen, Port Blair) White-collared Kingfisher.

♂ (wing 110 mm.) Bakultala, M.A.; 2 ♀♀ (109, 114) Shoal Bay Creek, S.A., and Bakultala, M.A.

This kingfisher, like the Whitebreasted, was frequently seen in the South and Middle Andamans in mangroves, among trees on the sea-shore and often quite far from water. A low trill was heard.

Hume found it feeding on centipedes and small lizards and saw it hammer shells on a lump of coral. One was similarly trying to knock to pieces a *Fusus* containing a red hermit crab.

I found the thick red claw of a crab in one stomach. Richmond (1903 : 301) found small fish and crabs in two stomachs.

Hume quoted Wardlaw Ramsay as informing him that he saw a pair going in and out of a hole in a tree near Mt. Harriet, probably with young. The male I collected on 22nd February had slightly enlarged testes. Osmaston (1906a : 163) found several nests in April and May, usually in holes and banks, only about a foot deep; occasionally also in holes in white-ants' mounds or in the upturned roots of a tree. He noted another in a hole in a mango tree, about 15 feet from the ground.

In flight, this bird often does not look like a kingfisher. One seen

on North Button Island on 29th February, appeared larger and of a different colour.

*743. **Halcyon chloris occipitalis** (Blyth) (Nicobars) Whitecollared Kingfisher.

♂ Car Nicobar ; 3 ♀♀ Car Nicobar; wing 113 (♂)-117 (♀), av. 115 (105-113) ; tail 69-80, av. 71·7 (65-72).

The bird was common in groves of coconut on Car Nicobar, looking very unkingfisher-like.

Davison said they commenced breeding at the end of February, and took an oviduct egg on 24th February. He found three nests on Camorta excavated in ants' nests, which are ' generally placed against the trunks of very large trees, but occasionally against those of the coconut palms at heights of from 4 to 20 feet from the ground, and vary from 10 to 30 inches in diameter, being composed of some sort of clay'. Butler (1899 : 562) refers to hornets occupying such a nest in which the kingfisher nested at Mergui.

Only one male and female have the buffy tinge on the underparts, but the larger size and the long buffy white supercilium are distinctive.

*745. **Merops leschenaulti andamanensis** Marien (Port Blair) Chestnutheaded Bee-eater.

2 ♂♂ Bambooflats, S.A., 9 Nov. 1963, and 17 March ;
2 ♂♂, 1 ♀ Wrightmyo, S.A. ; 1 ♀ Long Island, M.A.

Hume obtained a large series but did not think it different from specimens from Anjango in the South to Dehra Dun and Tipperah (1874 : 163). Marien (*J. Bombay nat. Hist. Soc.* **49** : 155) separated the Andaman birds by their larger size which is confirmed by the following measurements :

	Andamans			*India and Burma*	
	Wing	Tail		Wing	Tail
4 ♂♂	110-115	84-90	7 ♂♂	102-111	74-84
	av. 113	av. 86·25		av. 107	av. 80·7
2 ♀♀	109-112	86-88	9 ♀♀	104-109	78-83
	av. 110·5	av. 87		av. 105·8	av. 81

The heads of some birds, as in Indian birds, are darker than in others, but this difference does not appear to be linked with sex or season.

This bird was often seen in South and Middle Andamans, the blue back and reddish head being excellent points for identification. It has not been recorded in the Nicobars.

On 16th February I shot 2 males and a female; the gonads of the males were enlarged, those of the female were dormant. A bird dug out of a nest hole in the sandy bund of a paddy field (11th February), apparently still digging, was a male. Does this suggest

that the male has a more active share in the preliminary stages of nest-building etc. than the female ?

On 22nd February, a party of 10 to 15 birds appeared interested in holes in the bank of a nulla. The holes were not crowded together, being at least 10 yards apart. On 25th February, one of a pair was flushed out of an 18 in. hole, 3 ft. above the water-line in a mangrove creek. These records indicate an earlier or more prolonged breeding season than suggested by Hume (loc. cit.), who referred to their commencing to dig their nest in the middle of May. Osmaston (1906a : 162) found 3 to 5 eggs in tunnels often 4 ft. deep.

Butler (1899 : 561) refers to one clinging to a sandy bank and picking off small beetles running about on the sand.

The call is *tre* (tray)—*tre-tre* in a musical trill.

*748. **Merops philippinus philippinus** Linnaeus (Philippine Islands) Bluetailed Bee-Eater.

2 ♂♂ Bambooflats, S.A., 12 Nov. 1963 ; and Maymyo, S.A., 14 Feb. 1964.

Davison saw it in the Nicobars only (whence it is omitted in the SYNOPSIS), while Hume noted it in the Cocos. Butler said it was common in the Nicobars, and to be seen everywhere. Abbott and Kloss obtained 3 specimens, all males, on Camorta. Osmaston (1906a : 162) noted it as ‘ not common ’, seeing a few in March around Port Blair and on Narcondam in October. He thought they were on migration and did not stop in the Andamans. I saw it several times in open country in South Andamans, both in November and in February. There is no evidence of its breeding in the area, and it is probably a seasonal migrant from India. A bird shot in November contained dragonflies complete with wings.

*762. **Eurystomus orientalis gigas** Stresemann (Rutland Is., South Andamans) Broadbilled Roller.

♂ Port Blair, S.A., 4th Nov. 1963 ; 2 ♂♂ Betapur, Middle Andamans ; 1 ♂ 15 Feb., 1 ♂, 1 ♀ 24th March 1963, Chiria Tapoo, S.A.

Hume and Davison (1874) only saw it in South Andamans. I found it quite common both in South and Middle Andamans. It is not so much a bird of the open country as the Indian Roller (*Coracias benghalensis*) and, when perched on high trees on the edge of forests, it is not easily seen. The white spots on the wings are prominent in flight. Davison (loc. cit.) saw it ‘ rise into the air and go through a series of fantastic evolutions, sometimes keeping up for nearly three minutes ’. He added that its note was not musical and the bird was fortunately rather silent. I have already referred to mistaking it for a large nightjar at dusk. One stomach preserved was found to contain Chrysomelid

and Bupestrid beetles and grubs, crickets (Gryllidae), and bits of Mantids.

773. **Rhyticeros (undulatus) narcondami** (Hume) (Narcondam Is., Andamans) Narcondam Hornbill.

This bird is restricted to Narcondam Island, a steep jungle-covered hill rising abruptly from the sea 80 miles east of North Andamans. Very little is known of its habits. Hume (*Stray Feathers* **1** : 411) described its flight as heavy and slow. Osmaston (1905 : 620) estimated their total number at about 200 and found them noisy and fearless. Cory (*J. Bombay nat. Hist. Soc.* **14** : 372) visited the island on 22-3-1901 and found them paired, the cocks attentively feeding the hens as they sat together. The plumage of the specimens shot 'was in a draggled condition, the white tail-feathers being dirty and ragged and the whole appearance of the birds was as if they had been confined in an ill-kept aviary'.

*831. **Dryocopus javensis hodgei** (Blyth) (Andaman Islands) Great Black Woodpecker.

3 ♂♂ Ferrarganj, S.A., Bakultala, M.A., Long Island, M.A ; 2 ♀♀ Wrightmyo, S.A.

This fine woodpecker was fairly common in forest and even seen in mangroves. The male's call is a loud chattering *kuk*, *kuk*, *kuk*, ending with a whistling *kui*. A loud sharp *kik*, *kik*, *kik* was also heard. It was also heard drumming. The flight is flapping and roller-like. It was seen to jerk irregularly in flight, also like a roller, most unusual for a woodpecker.

A very pronounced musty smell was twice noticed in a male and a female, both with enlarged gonads. Ball (1870b) refers to a peculiarly rank and offensive smell in a specimen he procured in August. My specimens measured:

	Wings	Tails
3 ♂♂	182, 188, 185	138, 140, 147
2 ♀♀	190, 188	144, 144

The male (Ferrarganj) which had enlarged testes has a black forehead as in the female. Osmaston (1906a : 162) took a clutch of 2 eggs but does not mention the date.

Among the skins in the Society's collection, one of *Dryocopus javensis* from Kadra, North Kanara, has a few of the feathers of the back faintly tipped with red.

*846. **Dendrocopus macei andamanensis** (Blyth) (Port Blair, South Andaman) Fulvousbreasted Pied Woodpecker.

2 ♂♂ Wrightmyo, S. A., and Bakultala, M. A.; ♀ Pochang, Shoal Bay Creek, S. A.

This small woodpecker was common in wooded areas in both South and Middle Andamans, either singly or in pairs. Like many other

woodpeckers, it can reverse down the trunk and is sometimes within a few feet of the ground. It was also noted perched across a branch.

Osmaston (1906a : 161) found many nest holes on the underside of branches of avenue trees mostly *Pithecolobium saman*, but offers no additional information.

870. **Pitta sordida abbotti** Richmond (Great Nicobar) Hooded, or Greenbreasted, Pitta.

Hume saw a pitta with a great deal of blue about it at Galatea Bay, Great Nicobar, and thought that it might be *Pitta molluccensis*. The subsequent discovery of this bird by Abbott and Kloss no doubt establishes its identity. This form is found on Great and Little Nicobars.

*917. **Hirundo rustica gutturalis** Scopoli (Philippines) Swallow.

This swallow is common in the Andamans and Nicobars from September to May, young birds being far more numerous than adults (Butler). I saw parties, hawking over rice-fields etc. or settled on wires, several times in a 60-mile drive from Wrightmyo to Port Blair and back ; also at Bakultala, Middle Andamans, and on Car Nicobar. One shot on 11th February had a 107 mm. wing.

*920. **Hirundo tahitica javanica** Sparrman (Java) House Swallow.

Hume (1874 : 155) suggested that it was a monsoon visitor to the Andamans, being found only from June to end-September. Butler (1899 : 557) found it a common resident breeding in verandahs and outhouses. It was not recorded from the Nicobars, where he thought he saw one.

Earlier (*J. Bombay nat. Hist. Soc.* **11** : 736) he reported a pied specimen of this species obtained near Port Blair. Osmaston (1906a : 161) found 3 nests with hard-set eggs in caves on the shore of North Button Island on 5th May.

I think I saw this more than once in South Andamans, but always when busy with something else more important and so failed to secure specimens or to make quite sure of their identity.

949. **Lanius cristatus cristatus** Linnaeus (Bengal) Brown Shrike.

I took 3 specimens, one with a brown head and two with grey heads, assuming that the first was of this form and the others of the next ——both were noted in the field, roughly in the ratio of 1 to 5 or 6. I was apparently mistaken, for the specimen taken does not have the rich brown on the upper parts exhibited by specimens of *C. cristatus*. It would therefore appear to be an immature stage of *lucionensis*, though

the barring on the underparts is no more pronounced than in the adults. This identification has been confirmed by Dr. Ripley to whom the specimen was sent.

Hume said it was rare in the Andamans, only two of 32 shrikes collected being *cristatus*. Later it became more common and he received 8 killed in June, July, August, and September, indicating a migration.

*950. **Lanius cristatus lucionensis** Linnaeus (Luzon) Brown Shrike.

1 o? Mannarghat, S. A.; 1 ♂ Wrightmyo, S. A.; 1 ♀ Chiria Tapoo, S. A.

This bird was common in suitable localities in South and Middle Andamans, together with the brown form referred to under *cristatus*.

I saw no evidence of its breeding in the Andamans and also heard no call. Osmaston (1906a : 157) calls it a seasonal visitor, arriving in September and leaving in April. Richmond (1903 : 291) notes a specimen from Car Nicobar.

*956. **Oriolus chinensis andamanensis** Tytler (South Andamans) Blacknaped Oriole.

3 ♂♂ Wrightmyo, S. A.; 1 ♂ Bakultala, M. A., and 1 ♂ Guitar Island, M. A.; 1 ♀ Long Island, M. A.

This bird was common in most places in South and Middle Andamans.

During the earlier part of the trip, I syllabilized the call as *jug-jeevan* and thought it was very true. Later at Long Island, where the bird was quite common, its call was different and I never heard *jug-jeevan*!

5 males from South and Middle Andamans, including one in immature plumage, have their wings 130-140 mm. (av. 136·2), tails 90-104 (av. 97·8), and bills 29-31 (av. 30), while one female measures 133, 90, and 31 respectively. The nape patch in male No. 133 is 12 mm. broad, i.e. as in the Nicobar bird, but the other measurements are in keeping with those of this race.

Butler found nests on 19th May and 1st June, the former containing a large young and the latter 3 hard-set eggs. The second nest was much larger and more solid than the first, almost double in size. Osmaston (1906a : 158) noted them breeding from April to June. The nest, he said, was usually decorated outside with sprays of a small climbing Asclepiad with orbicular leaves.

957. **Oriolus chinensis macrourus** Blyth (Nicobar Islands) Black-naped Oriole.

♂ ♀ Car Nicobar: wings 154 and 151; tails 110 and 112; bills 30 and 33.

It was common on Car Nicobar, being noticeably larger and having a longer tail than the Andaman bird. It looked rather out of place in

coconut groves. Butler (1900, p. 396) said it was extremely abundant throughout the islands. I thought the call (which Butler terms a long drawn, modulated whistle, sounding like '*pee-u*') was also quite different from that of the Andaman bird, and have it written as *chee-e op*.

Oriolus xanthornus subsp. Blackheaded Oriole.

♂ Wrightmyo, S.A.: wing 131, tail 86, culmen 28.

They appeared common at Wrightmyo, and I noted several on North Button Island on 29 February.

Davison, who failed to see this species in December/January, but noted it in April and May, thought it was a migrant. Hume writing at the same time (1874 : 230) and Butler (1899 : 396) thought otherwise, their opinion being supported by specimens obtained, or birds seen, from March to September. Osmaston (1906a : 158) stated it was not uncommon in the hot weather, but he saw none in the winter.

Ripley (SYNOPSIS) says it is of the typical race (type locality : Chandernagore) and goes to the Andaman Islands in summer. My single specimen is too small for *xanthornus* and agrees in colour and size with *ceylonensis* Bonaparte. Whistler (*J. Bombay nat. Hist. Soc.* **36**: 585) said that Andaman birds appeared to be smaller than the Ceylon form, but did not express any further opinion as it was believed to be a migrant [see also Walden (1874c : 138)]. I am for the moment leaving this bird trinomially unnamed.

Dicrurus leucophaeus subsp. Grey Drongo.

Capt. Wimberley sent Hume a specimen obtained on 5 November (1874 : 210). Later (1876 : 289) he said it was *leucogenys* Walden.

[970. **Dicrurus annectans** (Hodgson) (Nepal) Crowbilled Drongo.

Under *D. balicassius* (Linnaeus) Blyth (*Journ. Asiatic Soc. Bengal* 1846 : 30) wrote that a specimen of this common Malayan species was obtained by Capt. Lewis when nearing one of the Nicobar Islands. This is later repeated by Hume. This species is migratory and passes through portions of Burma in large numbers, presumably into Malaya. In view of the doubts expressed regarding the origin of birds obtained by Capt. Lewis, it may be best to omit it from the Nicobar list until reconfirmed.]

974. **Dicrurus andamanensis dicruriformis** (Hume) (Great Coco and Table Island) Andaman Drongo.

Ripley (SYNOPSIS) restricted this form to Great Coco, Table, and North Andaman Islands, while *andamanensis* described from Port Blair was said to occur on South Andamans only. The intermediate area

(Middle Andamans) is occupied by an intermediate form as indicated under *D. a. andamanensis*, below.

*975. **Dicrurus andamanensis andamanensis** Tytler (Port Blair) Andaman Drongo.

5 ♂♂ Port Blair, 14 Nov. 1963; Ferrarganj, S. A., Chiria Tapoo, S. A., Bamboo-flats, S. A., Long Island, M. A.; 2 ♀♀ Mannarghat, S. A., Long Island, M. A.

I saw this species common in forested areas in South and Middle Andamans. A party of 7 to 8 was seen together in a forest clearing. One clung to the smooth trunk of a high tree like a woodpecker, released its hold, and clung again higher up. The call was a long *tseep*. It also had some ringing notes typical of the drongos.

Wardlaw Ramsay (*Stray Feathers* **2**: 211) noted it going up a tree like a woodpecker. Oates, in the old FAUNA, said it was highly gregarious, flocks of half a dozen to twenty travelling through the forest in search of food, either by themselves or in company with *Irena puella*, *Sturnia andamanensis*, *Graucalus dobsoni*, *Pericrocotus andamanensis*, etc. Osmaston (1906a : 156) found it breeding from the middle of April to the middle of May.

The 5 males collected have their wings 134, 135 (2), 136, and 142 mm., the last being from Long Island, the northernmost point of my trip. Stuart Baker held that birds with wings under 140 mm. were of this race, while those over 140 were *dicruriformis* Hume.

Two females from South and Middle Andamans have wings 128 and 131 mm., indicating that they are smaller than the males, though Hume (*Stray Feathers* **1** : 408-9) when describing the larger race *dicruriformis* appears to have measured both sexes together.

*980. **Dicrurus paradiseus otiosus** (Richmond) (Andamans) Greater Racket-tailed Drongo.

2 ♂♂ Long Island, M. A., Port Blair, S. A. (18 March 1964); 3 ♀♀ Wrightmyo, S. A., Mannarghat, S. A., Long Island, M. A.

Tolerably plentiful in suitably forested areas. It has the same range and variety of calls as the Indian race. Osmaston (1906a : 157) said it bred in May, building its nest generally high up on the more or less inaccessible branches of big trees.

The subspecies *grandis* (Gould) was separated because of its long crest. Sálim Ali in 'Birds of Gujarat' (*J. Bombay nat. Hist. Soc.* **52**:800) specially drew attention to the short crest of the birds collected in the Surat Dangs and other places in Gujarat and identified them as *malabaricus* (Latham). Ripley in the SYNOPSIS has included Gujarat in the range of *grandis* and synonymized *malabaricus* with *paradiseus* of which the type locality is in Thailand.

981. **Dicrurus paradiseus nicobariensis** (Baker) (Kondel, Nicobars) Greater Racket-tailed Drongo.

This species is apparently scarcer in the Nicobars than in the Andamans (Davison & Hume 1874 : 213), though Butler (*J. Bombay nat. Hist. Soc.* **12** : 392) refers to both races together and notes them as fairly common in both the Andamans and Nicobars.

*983. **Artamus leucorhynchus humei** Stresemann (Andamans) Swallow-Shrike.

1 o ? Wrightmyo, S. A., 1 ♂ Wrightmyo, S. A., 2 ♀♀ Wrightmyo, S. A., and Bakultala, M. A.

The Swallow Shrike was commonly seen in open country over paddy-fields and in rubber. Their habits are very similar to those of the Indian species, *fuscus,* though they appeared to settle more often on the ground and to be generally tamer in disposition. They huddled closely together on horizontal branches, both to roost at night, and during the day.

Butler saw it following the plough, alighting among the newly-turned clods of earth in search of insects exposed, and moving on the ground in short hops. He also saw them settle on the roofs of houses. He said he had frequently killed a flying bird with a catapult!

Davison found a nest, still empty, on 2nd May and Butler saw newly-fledged young sitting about in trees in May.

Osmaston (1906a : 157) found them breeding in April and May, the nests being almost invariably placed on the broken-off stump of some stout branch 10 to 20 ft. from the ground. The nest was an untidy shallow saucer of twigs little better than that of a dove, and exposed to view from above, and more or less also from below.

On 27 February on Long Island I saw two pairs collecting grass from a drying lawn outside the Divisional Forest Officer's bungalow, settling on the ground to do so. The nest was being built in a hole (?) in the top of a dry vertical branch, 3-4 in. in diameter, in a gigantic *gurjan* some 200 ft. up and 300 yards distant. The other was in the fork of a tree, about 20 ft. from the ground, and only about 50 yards away. I saw two birds on a branch 20 ft. from the nest, displaying to each other, both rotating their expanded wings. One then sidled up to the other which flew to the nest post.

The call is of the same type as that of the Indian bird but softer.

This bird is found in the Andamans, and on Great Coco and Table Islands.

*986. **Aplonis panayensis tytleri** (Hume) (Andamans) Glossy Tree Stare.

3 ♂♂ Wimberleyganj and Mannarghat, S. A., Long Island, M. A. ; 1 ♀ Maymyo, S. A. ; 2 ♀♀ Car Nicobar ; 1 ♂, 1 ♀ Nancowry Island, Nicobars.

This was common in the South and Middle Andamans and also at

Car Nicobar, both in pairs and in parties, large and small. Large flocks of several hundreds, flying to the tops of trees created a spotted appearance thereon. Very few streaked young were noted in the Andamans, while they appeared common on the single day's trip to Car Nicobar.

In early February, they appeared to be preparing to breed, a male shot on the 11th showing enlarged gonads, and two birds were seen contending for a nest hole high up in a tree about the same time.

Osmaston (1906a : 158) found them exceedingly numerous from about February till June, but could not ascertain where they went for the rest of the year. Tytler (1867 : 330) obtained young in August.

The specimens are not enough to permit any definite conclusions, but the 3 adults from the Andamans show noticeably more of the greenish gloss on their upper parts than those from Car Nicobar. A female from Nancowry in immature plumage (with spotted underparts) is also less green above than a similar male from the Andamans which is almost as green as the adult. The last specimen is also more heavily spotted on the underparts than the other.

Hume (*Stray Feathers* **1** : 481) referred to great variation in the colour of the irides in adults, varying from white, opalescent white, fleshy white, and pale pink to brown, deep brown, deep red-brown, and deep orange. This was on the basis of sixty specimens 'from almost every island in both groups'. It is interesting to note that Abbott and Kloss (in Richmond, 1903) found that the birds from Car Nicobar had brown irides, while all from the central group, Trinkut etc., and Great and Little Nicobar, had them white.

*990. **Sturnus erythropygius andamanensis** (Tytler) (Andamans) White-headed Myna.

2 ♂♂ Chiria Tapoo, S. A., and Long Island, M. A. ; 2 ♀♀ Wrightmyo, S. A., and Bakultala, M. A.

This myna was as Butler noted one of the commonest birds in the Andamans. I also saw a pair on North Button Island. Butler notes that they work through the forest in company with Racket-tailed Drongos, Minivets, and Cuckoo Shrikes. He also said that it was partial to 'a small caterpillar which rolls itself up in the narrow leaves of the bamboo, and flocks may be seen hanging in all sorts of tit-like attitudes diligently opening every rolled-up leaf with varying results, the little shelter not being always tenanted'.

In the forested areas it keeps to the trees, though it is possible, as Butler recorded, that it feeds a good deal on the ground in paddy fields. When seen at eye-level the pale back is noticeable, and my first impression of a large flock was of rosy pastors. Osmaston (1906a : 158) took nests at the end of April and in May. The nests with 4 eggs were in holes in trees from 6 to 30 feet high, and 'composed of small

pliant twigs with an occasional stiff feather, and lined with small green leaves'.

*991. **Sturnus erythropygius erythropygius** (Blyth) (Car Nicobar) Whiteheaded Myna.

1 ♂, 2 ♀♀ Car Nicobar.

It was common on Car Nicobar and did not appear to vary in habits from *S. e. andamanensis*. At the time of Hume's trip it was believed to be a very rare species, only one specimen being obtained though Butler found it common.

992. **Sturnus erythropygius katchalensis** (Richmond) (Katchal Is., Nicobars) Whiteheaded Myna.

Richmond (1903 : 293) while describing this race from Katchal Island refers to Hume some thirty years earlier mentioning *andamanensis* being introduced at Kamorta, and suggests that the population on the adjacent island of Katchal is a hybrid between *andamanensis* and *erythropygius*. Ripley (1961 : 297) agrees with this possibility. It differs from *erythropygius* in the smaller measurements and the pale rump and upper-tail coverts of *andamanensis*, but has the under-tail coverts as in *erythropygius*.

995. **Sturnus sturninus** (Pallas) (Dauria) Daurian Myna.

Hume (1874 : 251) refers to 2 shot out of a flock of 70-80 at Camorta, and a third flew on to the boat between Little Andamans and Nicobars. They were all in immature plumage. Hume did not appear quite sure about their identification.

996. **Sturnus roseus** (Linnaeus) (Lapland, Switzerland) Rosy Pastor.

Tytler made a general statement that 'it arrives in flocks in January' (in the Andamans). Several later observers failed to see this species and Tytler's observations were treated with doubt. Osmaston (1906a : 158) however saw two flocks in March and April and obtained three specimens. He suggested it was possible that they visited the Andamans only in very severe winters.

1006. **Acridotheres tristis tristis** (Linnaeus) (Pondicherry) Indian Myna.

1 ♀ Wrightmyo, S. A.: wing 130.

This bird was introduced by Col. Tytler at Ross Island. When Hume visited the place (1873), he said that they had thriven and multiplied greatly but not crossed over to Port Blair which is not more than a quarter of a mile away. By Butler's time (1900) it was one of the commonest birds at Port Blair, being very abundant wherever there was cultivation and roosting in hundreds in clumps of bamboos. Now, they are common in suitable areas throughout the South Andamans, but I

did not notice any large flocks. Butler said they had been introduced at Camorta, where he saw some, as did Abbott and Kloss, who also noted them at Nancowry Harbour.

Though the FAUNA states that the wings of the typical race measure 140-149, there are several smaller specimens in the Bombay collection.

[**Acridotheres fuscus** from Burma was also introduced by Tytler, but there is no evidence of their subsequent survival.]

*1018. **Gracula religiosa andamanensis** Beavan (Andamans) Hill Myna.

2 ♂♂ Betapur, M. A.; 2 ♀♀ Wimberleyganj and Bambooflats, S. A.; 1 ♂ Port Blair 17 March 1964.

I found it common in most places in South and Middle Andamans, and it is said to be found all over the Nicobars too. An albino was obtained in the Nicobars (Blyth, 1863b). Hume refers to their being perfect mimics and being sold at Calcutta at Rs. 3 to Rs. 5 against 4 to 8 annas at Port Blair. Osmaston (1906a : 158) said the trade was forbidden.

Three males from the Andamans have their wings measure 174, 166 and 165 mm. against 183 (Little Nicobar) and 170·5 and 177·5 (Katchal) mentioned by Richmond (1903 : 292).

*1040. **Dendrocitta bayleyi** Tytler (Andamans) Andaman Tree Pie.

3 ♂♂ Wrightmyo, S. A., Bakultala, M. A., and Chiria Tapoo, S. A.; 3 ♀♀ Wrightmyo (2) and Chiria Tapoo.

I saw this small tree pie in South and Middle Andamans and got the general impression that it was not common. However, I saw several parties, and the fact that as many as 22 flew out of a tree suggests that they are not really very scarce. They were seen together with Racket-tailed and Andaman Drongos. In flight it looks more like a drongo than a tree pie, its thin body showing only as a streak in silhouette. Parties broken up into twos and threes kept together, flying and turning in the air in formation.

Of the two females collected on the same day, one had olive-green irides and the other bright yellow. Butler (1899 : 390) said that the young start with an olive-green iris, changing in a short time to bright green. An inner circle of golden yellow then appears and gradually encroaches on the green until the beautiful clear yellow eye of the adult is attained.

Eggs were taken near Port Blair in March and April (FAUNA 1 : 56).

***Corvus macrorhynchos andamanensis** Tytler (Port Blair, Andamans) Jungle Crow.

1 ♂ Middle Button Island; 1 ♀ and 1 o? Wrightmyo, S. A.

This crow was seen at all camps in South and Middle Andamans,

Two specimens shot on 11th February showed no signs of breeding but one bird was seen carrying a stick to a coconut palm on the 15th.

Osmaston (1906a : 156) found them breeding in March, frequently on coconut palms. Beavan (1867) said : ' It is abundant in large flocks and formerly fed entirely on the seashore .... but now frequents houses and barracks for offal '. The tendency to congregate in flocks is said to be very different from that of Indian birds. I did not notice any large flocks.

The Jungle Crows from the Andamans were named *andamanensis* by Tytler and were said to be (Ball, *Stray Feathers* **1** : 74) quite distinct from *C. culminatus*, being ' nearer *intermedius* of the Northwest Himalayas, but slightly larger than that species '. Blyth said the specimens seen by him were *culminatus*, while Beavan, who was inclined to agree with Col. Tytler, noticed that the call was quite different. Hume (*Stray Feathers* **5** : 461-469) examined 70 skins from the Indian region and, considering sizes of wing, culmen, tail, and tarsus, shape of tail, green or purple gloss, and white and non-white base of feathers, came to the conclusion that *culminatus*, *intermedius*, *levaillanti*, and *macrorhynchos* were not separable as species. Blanford (FAUNA **1** : 17) included *andamanensis*, *intermedius*, and *culminatus* under *macrorhynchos*, but mentioned that the smallest birds occurred in the north-west Himalayas and the largest in the Andamans and Burma. Stuart Baker (FAUNA **1** : 29) accepted *andamanensis* from the Andamans, Burma, and north and west Siam on their larger size (♂ wing 304-345, av. 325 ; ♀ 290-321) and larger bills (never under 58, generally over 60, and running up to 70). He said that in all the island adults the bases to the feathers are very pure white, whereas in the Assam and Burmese birds they range from almost pure black to more than equally pure white. Northern birds had more white than southern, ' but even this is only a question of degree in average '. Stanford & Mayr (*Ibis* 1940 : 695), reporting on the Vernay Cutting Expedition to northern Burma, referred to birds from the Andamans (*andamanensis*) having male : wings up to 340 mm. and female : up to 325 mm., bill slenderer, nape feather bases white, and being probably identical with birds from Lower Siam and the Malay Peninsula, and intermediate between *levaillanti* and *macrorhynchos*. Ripley (1961) accepts *intermedius*, *levaillanti*, *tibetosinensis*, and *culminatus* from the region but omits *andamanensis*, making no statement as to what form is found in the Andamans.

Upon arrival at Port Blair, it was immediately noticeable that the call of the Andaman bird was different from that of the Jungle Crow with which I am familiar, *culminatus*, being plaintive and less harsh.

The 3 specimens obtained, one ♂ (wing 320, tail 195), one female (287, 168), and one unsexed (probably female, wing 287, tail 167), are very black above and below and with little gloss, and the male is

too large for *culminatus*. Hume (1874 : 243) said that, sex for sex, the Andaman birds had a longer bill than any continental race. This difference is not visible, and the bills of the three specimens vary in shape among themselves. The nape feather bases of the male are dark grey [as in all the specimens of *culminatus*, *intermedius*, *levaillanti*, and *tibetosinensis* available in Bombay (except a male from Chitral)], while the two smaller birds have them white. This difference shows an affinity with *macrorhynchos*. It is apparent that the over-all position regarding the geographical variations of this common bird are still far from completely understood and, though I cannot express any definite opinion with the series available here (Blanford examined 300 at the British Museum!), I think it advisable to retain my specimens as *andamanensis*.

Davison (Hume 1874 : 244) refers to a few taken from Port Blair and turned loose on Camorta, and on the adjacent island of Trinkut in the Nicobars. Later (*Stray Feathers* **3**: 325) Hume, while dealing with birds from Tenasserim, says their bills are about the same as those of Nicobar birds, while the wings are perhaps somewhat larger. I have not seen any other reference to their occurrence in the Nicobars, and can only assume that this is a slip for the Andamans.

[**Corvus splendens** Vieillot, introduced by Col. Tytler for sanitary purposes, does not appear to have thriven or multiplied (Beavan, 1867 : 329).]

*1075. **Coracina novaehollandiae andamana** (Neumann) (Andaman Islands) Large Cuckoo-Shrike.

2 ♂♂ Wrightmyo, S. A., and Long Island, M. A. ; 1 ♀ Betapur, M. A.

Butler said it was common in the neighbourhood of Port Blair, where clearing and cultivation had made the country open enough for its liking. Osmaston (1906a : 157) found nests on 14th May and 4th June, both with 2 fresh eggs. I did not find it common, though I saw it on both South and Middle Andamans. It does not occur in the Nicobars.

*1076. **Coracina striata dobsoni** (Ball) (Andamans) Barred Cuckoo-Shrike.

1 ♂ ? (wing 169), 1 ♀ (158) Wrightmyo, S. A.

I obtained two specimens at Wrightmyo, South Andaman. One of them had flown in from the mangrove late in the evening and settled high in a tree on the edge of forest.

Butler stated that this species was common in forests, where it was quiet, associating with mynas, minivets, drongos, etc., which roam

through the jungle in company. He also referred to a rather pleasing short song and the absence of the noisy whistling cry of the Large Cuckoo Shrike.

The FAUNA (**2** : 346) gives the male wings as 153-166 and female 151-160, while Richmond (1903 : 292) measures a Nicobar male 170 mm. and a female 172.5.

Lalage nigra davisoni Kloss (Nicobar Islands).

Davison (Hume 1874 : 202) found it not uncommon about the settlement at Camorta, in small parties of five or six or in pairs, in low scrubby undergrowth, feeding close to the ground. They were not shy and he shot two or three from the same tree.

This species is omitted from the SYNOPSIS.

*1080a. **Pericrocotus flammeus andamanensis** Beavan (Andamans) Scarlet Minivet.

3 ♂♂ Wrightmyo, S. A.: wing 93, 93·5, 96; tail 91, 87, 88; 1 ♀ Pochang, Shoal Bay Creek, S. A.: wing 92, tail 93.

The largest male (wing 96, tail 88) had grey on the upper back and nape, flecks of scarlet on the forehead, and the chin mottled irregularly with black and orange. The black extending over the whole length of the central tail feathers is a distinctive character.

Osmaston (1906a: 157) noted it as fairly common, frequenting the crowns of trees in small parties.

Butler noted a single male of *P. cinereus* Lafr. with a party of *andamanensis*. He shot the bird but did not preserve it as it was badly damaged. This has been omitted by subsequent workers.

***Pericrocotus cinnamomeus** subsp. Little Minivet.

2 ♂♂ Wimberleyganj, S. A., and Long Island, M. A.; 3 ♀♀ Wimberleyganj, S. A. (2) and Long Island, M. A.

I saw this quite often in South and Middle Andamans. Butler (1899 : 394) said : ' Parties of this bird are extremely regular in their habits, working their way to new roosting places, along the same line of trees, night after night . . . . I have several times seen a whole party flutter down after a shot bird (dead or living) and remain several seconds by it on the ground, moving with very short hops .' He added that they bred from May to July; a pair was watched nest building on 15 July, the female doing all the work with the male keeping within a yard of her all the time. Osmaston (1906a : 157) found several nests in May and June.

The SYNOPSIS includes birds from the Andamans in the range of *vividus* Stuart Baker (type locality Attaran River, Amherst District,

Burma; restricted by Deignan to Pabyouk, 22 miles south-east of Moulmein).

There is only one specimen from Burma (Maymyo) in the Bombay collection and this has a grey chin against dark, almost black, in the 2 males from the Andamans. The whole of the lower plumage in the latter is also washed with orange-red and compares well with specimens from Badrana, Barkot, Keonjharghad, Simlipal Hills, in Orissa, which appear to be listed under typical *cinnamomeus* in the SYNOPSIS. In addition to these differences and similarities, the bill of one Andaman male is heavier than in any of the other specimens in the Bombay collection.

***Irena puella andamanica** Abdulali (Long Island, Middle Andamans) Fairy Bluebird.

5 ♂♂ Wrightmyo, S. A. (2), Bakultala, M. A. (2), Long Island, M. A.; 1 ♀ Wrightmyo, S. A.

I found it in all forested places in South and Middle Andamans and, as noted by Hume (1874 : 226), the number of females appeared to preponderate over the males in adult plumage to a remarkable degree—while he saw one male to 4 or 5 females, my impression was one in 20 (as also Butler's).

They were often seen in parties of 15 to 20 birds, on trees and bushes bearing berries on which they fed, e.g. *Phyllanthus columnaris*. The birds would all arrive at the bush together and then fly away after a few minutes, apparently doing a *chukker* in company. A loud *pit-pit-pit* was often uttered. Males in adult plumage were often seen alone in heavy forest.

Hume (loc. cit.) referred to young being out in April and Butler states that two males shot on 9th June were breeding. They have been recorded from both groups of islands and there is evidence of some form of local migration. Osmaston (1906a : 156) found it numerous around Port Blair from September to March, but did not find a nest and rarely saw it between April and August.

*1113. **Pycnonotus atriceps fuscoflavescens** (Hume) (Port Mouat and Mt. Harriet, South Andamans) Blackheaded Bulbul.

5 ♂♂ Wrightmyo, S. A. (3), Bakultala, M. A., Port Blair, S. A. (17th March); 2 ♀♀ Wrightmyo, S. A., Bakultala, M. A.

This bulbul was not common but, as Butler noted, is a quiet unobtrusive bird keeping to heavy jungle. I saw it at all camps and the position must be different from what it was when Davison and Butler collected — the former obtaining 8 specimens in six months and the latter not seeing it more than a dozen times in eight months. Osmaston (1906a : 156) also said it was decidedly rare, seeing it half a dozen times in 15 months.

*1122. **Pycnonotus jocosus whistleri** Deignan (Cinque Island, south of South Andaman) Redwhiskered Bulbul.

1 ♂, 3 ♀♀ Wrightmyo, S. A.; 1 ♂, 2 ♀♀ Nancowry, Nicobar.

This bird was common in South and Middle Andamans, in the more open country. It was introduced into the Nicobars, where Hume saw it on Camorta. Osmaston (1906a : 156) said at Port Blair they frequently entered houses, taking the place of the Common Sparrow. He said they bred from March to May laying 2 or 3 eggs only. Richmond (1903:289) said that they differed from Indian and Malayan examples in being rather darker and browner above, with more extensive white tips on the rectrices, but did not specify which of the several races he compared them with.

As Walden noted in 1873, this form is barely distinguishable from *emeria* from Vizagapatam, Orissa, and Bastar, though the red ear-tuft and the crest are on an average shorter and the bills heavier.

*1142. **Hypsipetes nicobariensis** Moore (Nicobars) Nicobar Bulbul.

1 ♂, 1 ♀ Nancowry Island, Nicobars, 14 March 1964.

This bird is restricted to the Nicobars, where it is not found on Car Nicobar (Butler). Shekar obtained two during a short trip to Nancowry Island. Both had their gonads under. Davison reported it as common in the Nicobars, keeping to forests but sometimes in gardens. He saw them singly, in pairs, or in small parties of 5 to 6. Abbott & Kloss (in Richmond 1903:289) said they ' occasionally congregate in assemblies of 50 or more in some large tree, where they make a great chattering and uproar '.

1402. **Rhinomyias brunneata nicobarica** Richmond (Great Nicobar) Olive Flycatcher.

Abbott & Kloss found it common on Great and Little Nicobar. They kept close to the ground in low bushes in heavy forest and had a ' rather sweet song '. Ripley (1961 : 419) states that the breeding range of this form is unknown and it may be resident in the Nicobars.

*1407. **Muscicapa latirostris** Raffles (Sumatra) Brown Flycatcher.

2 oo ? Betapur, M. A., Bambooflats, S. A., 20 March, 1964;
1 ♀ Long Island, M. A.

This is a winter visitor to the Andamans only, apparently in some numbers, for we saw it at all camps.

1464. **Terpsiphone paradisi nicobarica** Oates (Nicobars) Paradise Fly-catcher.

Though it occurs in both the Andamans and the Nicobars, we did not see it. Davison saw white and red birds but said it was rare in both the

groups. Abbott & Kloss did not see it on Car Nicobar or Tillangchong, but found it fairly common on all the other islands of the Nicobars. They noted adult white males on Great and Little Nicobar.

*1467. **Monarcha azurea tytleri** (Beavan) (Port Blair, Andamans) Blacknaped Flycatcher.

3 ♂♂ Bakultala (1), Long Island, M. A. (2) : wings 72-75, av. 73·3;
2 ♀♀ Wrightmyo, S. A. (1), Long Island, M. A. (1) : 2 ♀♀, 71-73, av. 72.

This flycatcher, seen at all camps in South and Middle Andamans, is said to extend to Great and Little Coco (SYNOPSIS). Osmaston (1906a : 159) found many nests between 8th April and 1st June, which were invariably decorated with white spider egg-cases.

The underparts of the male are bluer than in Indian birds. This colour extends to the vent, replacing the white in Indian and Nicobar birds.

*1468. **Monarcha azurea idiochroa** (Oberholser) (Car Nicobar) Blacknaped Flycatcher.

2 ♀♀ Car Nicobar : wings 73·5 and 74 mm.

The white belly separates this from the Andaman birds. This form is presumably restricted to Car Nicobar.

1469. **Monarcha azurea nicobarica** (Bianchi) (Nancowry) Blacknaped Flycatcher.

This form, said to be slightly larger than the last, replaces it in the other islands of the Nicobar Group. I have not seen any specimens.

*1470. **Pachycephala cinerea cinerea** (Blyth) (Ramree Island, Arrakan) Mangrove Whistler.

[*Muscitrea grisola grisola* (Blyth) in FAUNA]
1 ♂ Long Island, M. A.

Osmaston (1906a : 159) found it throughout the Andamans, but not common though fairly numerous in open jungles and clearings near Port Blair. He said : '[It has] a fine loud and clear whistle, repeated three or four times or prolonged and drawn out, followed suddenly by a higher (or lower) note in a different key, reminding one somewhat of the call of *Aegithina tiphia* and unlike that of any flycatcher. It is a quiet and unobtrusive bird usually seen alone or in pairs. It frequents mangroves and other small trees and catches insects sometimes on the wing and at other times on the branches or trunks of trees.'

He found it breeding in May and June, and took 5 nests with 2 eggs each between 17 May and 10 June. The nest was a thin, flimsy cup-shaped structure attached by means of cobwebs to the twigs supporting it 5 to 12 feet from the ground.

Abbott & Kloss (Richmond 1903 : 295) obtained six specimens from Henry Lawrence Island, Barren Island, South Andaman, and Cinque Island. Curiously, others found it scarce, Butler seeing it only once. The only specimen we obtained was shot by Shekar on Long Island, Middle Andamans.

1475. **Cettia pallidipes osmastoni** (Hartert) (Andaman Is.) Bush Warbler.

Butler shot one in dense undergrowth on top of Mt. Harriet, South Andaman. Osmaston (1906a : 157 and 1933 : 892) said they were adept skulkers and common in dense undergrowth of high or secondary forest, but never met in the open. He describes the deep cup-shaped nest as built of dry bamboo leaves, loosely put together and lined with fine flowering grass-heads supported among the stems and leafstalks of a ginger-like plant in dense jungle. The nest contained 4 eggs. He also noted the call as ' most characteristic and peculiar, of 3 or 4 notes only, loud for the size of the bird, and insistent '.

I did not meet this species and it would appear to be very localized.

***Cisticola juncidis malaya** Lynes (Klang, Selangor, Malay State) Fan-tail Warbler.

1 ♂ Car Nicobar.

Davison obtained specimens in the Nicobars where, Butler said, they were common. Abbott & Kloss secured 4 specimens on Trinkut and noted them on Kamorta and Nancowry. They also saw another small bird on Great Nicobar, which they took to be some species of *Cisticola*. The specimens were not subspecifically named, but Dr. Dillon Ripley (*in epist.*) informs me that they are of this race as also the above-mentioned specimen which was sent to him.

I found them quite common at the aerodrome and in similar areas of short grass on Car Nicobar. The specimen obtained has not the streaked back of Indian birds.

Hume (1874 : 235) referred to great variations in individuals and confirmed that birds from the Nicobars are identical with those from India. This is an addition to the list in Indian literature, though the Nicobars are included in the range of this race by Chasen (1939, **4** : 327).

1542. **Locustella certhiola centralasiae** Sushkin (Khara Usu River, Khanghai, Northwestern Mongolia) Pallas's Grasshopper Warbler.

1543. **Locustella certhiola rubescens** (Blyth) (near Calcutta) Pallas's Grasshopper Warbler.

Butler has a single sight record of Pallas's Grasshopper Warbler from the Andamans and Abbott got one at Kamorta, 10 February

(Richmond, 1903 : 291), the race being undetermined in both cases. Ripley (1961 : 462) includes both races in the Andamans, mentioning that, when Sushkin (1925) described *centralasiae* [*Proc. Boston Soc. Nat. Hist.* **38**(1) : 46], he referred to it as a winter visitor to the Andamans.

1544. **Locustella lanceolata** (Temminck) (Mainz ?) Streaked Grasshopper Warbler.

This was first obtained by Davison near Port Blair and described by Hume as *L. subsignata* (1873b : 409). Davison referred to its running along the ground. Butler said it was fairly common in the Andamans in winter.

*1549. **Phragamaticola aedon aedon** (Pallas) (Dauria) Thickbilled Warbler.

1 ♂ Long Island, M. A. : wing 81 mm.

Davison and others found it not uncommon in hedges, thickets, etc. in the Andamans and rare in the Nicobars during the cold weather. The call and alarm note a *click-click* was likened by Davison to the cocking of a very coarse-springed musket-lock. He also heard them make 'a very good attempt at a song somewhat weak and monotonous perhaps, but very pleasing withal'.

I only obtained one specimen on Long Island on 28th February.

*1552. **Acrocephalus stentoreus amyae** Baker (Hessamara, Assam) Great Reed Warbler.

1 ♂ Choldhari, S. A.

On 14th February large warblers appeared to be common in grass in and on the edge of snipy country. Two were obtained, of which one is of this species and the other of the next.

Both were identified by Dr. Dillon Ripley and this is an addition to the Andaman avifauna.

There is yet no evidence of its breeding in the Andamans, and this appears to be the first indication of the migration of this form.

*1554. **Acrocephalus orientalis** (Temminck & Schlegel) (Japan) Eastern Reed Warbler.

1 ♂ Choldhari, S. A.

The specimen was obtained in the circumstances referred to under the last species. This is said to occur in the Andamans in the SYNOPSIS but I cannot trace the original record.

*1585. **Phylloscopus fuscatus mariae** Ripley (Moirang, Manipur) Dusky Leaf Warbler.

1 o ? Bakultala, M. A. : wing 64.

As the specimen could not be identified in Bombay, it was sent to

Dr. Dillon Ripley, who has identified it as of this form; this is a new record for the Andamans. Vaurie (1954, *Amer. Mus. Novit.* 1685 : 16), who does not accept this race, refers to specimens from the Andamans, showing characters of this form, and I do not know if nominate forms should be retained for this area.

1586. **Phylloscopus fuscatus fuscatus** (Blyth) (Neighbourhood of Calcutta) Dusky Leaf Warbler.

This race is included in the Andaman avifauna in the SYNOPSIS, presumably on the basis of specimens obtained by Davison in South Andamans, and also by Osmaston (1906a: 157) who found it common in and around Port Blair in winter and said it had a sharp 'clicking' note.

1600. **Phylloscopus borealis borealis** (Blasius) (Sea of Okhotsk) Arctic Leaf Warbler.

Walden recorded one specimen from South Andamans, and two from the same area are mentioned by Oates. Kloss obtained one on Little Andaman (Richmond 1903 : 291).

1601. **Phylloscopus magnirostris** Blyth (Calcutta) Largebilled Leaf Warbler.

The single specimen obtained by Hume (1874 : 236) at Mt. Harriet, South Andamans, appears to be the only record.

*1604. **Phylloscopus trochiloides trochiloides** (Sundevall) (Calcutta) Dull Green Leaf Warbler.

2 ♂♂ Wrightmyo, S. A., and Bambooflats, S. A.: wings 64 & 66; tails 49 & 50.

Hume (1874 : 236) refers to 2 specimens from Mt. Harriet and Great Coco, and Butler also said it was not uncommon in the Andamans in winter but not numerous. Abbott obtained specimens in South Andamans, which, as also the earlier records, are under the name *lugubris*. My specimens were identified by Dr. Dillon Ripley.

Phylloscopus tenellipes (Swinhoe) (Amoy) Palelegged Leaf Warbler.

Richmond (1903 : 291) mentions this species as captured on a boat 10 miles E. of Great Nicobar, but it is not mentioned in the SYNOPSIS.

Erithacus svecicus subsp. Bluethroat.

Hume (1874 : 234) refers to this bird as a winter visitor to the Andamans, but this is omitted in the SYNOPSIS.

*1664. **Copsychus saularis andamanensis** Hume (Andamans) Magpie-Robin.

3 ♂♂ Mannarghat, S. A., Bakultala, M. A., Port Blair, 20 March; 2 ♀♀ Mannarghat, S. A., Bakultala, M. A.

The Magpie Robin was occasionally seen near villages and in scrub

jungle in both South and Middle Andamans, but I would not call it abundant (Blyth 1863b).

It also appeared to keep nearer the ground than the Indian form, and was, on several occasions, seen among the rocks on the sea-shore, the forest in such places almost reaching the tidemark. Osmaston (1906a : 159) found a nest with 4 eggs about 6 ft. from the ground, from March to June.

The specimens differ from Indian birds in the males having the grey on the sides of the lower abdomen extending towards the white centre, the wing quills darker (more sheen), and the bills of both sexes heavier. The females also have more sheen on the upper plumage.

1668. **Copsychus malabaricus albiventris** (Blyth) (Andamans) Shama.

(Colour plate in *Ibis* 1873, p. 313).

I did not find this bird. Hume (1874 : 232) said it had ' no voice, no ear and not the faintest conception of singing ', to which Davison added : ' it gives utterance to a series of hoarse sounds which would appear to proceed from a bird the size of a crow and perhaps of the same family '.

Osmaston (1933 : 891) said they were common in all the densely forested portions of the larger and smaller islands, frequenting ravines near water. They were also said to have some fine loud clear notes, as well as some harsh ones ; tame birds copied tunes whistled to them with great accuracy, one even reproducing ' Way down upon the Swanee River '. He found 7 nests between 21st May and 27th June, all at a height of 5-8 ft. from the ground (1906a : 160).

1697. **Saxicola torquata indica** (Blyth) (Calcutta) Stone Chat.

Davison and Hume (1874 : 233-234) both saw and obtained specimens in South Andamans, though it was noted as rare. Hume (1873 : 307) refers to a very long, broad, and conspicuous whitish superciliary streak.

Osmaston (1906a : 159) saw it once in March near Stewartganj. This would of course only be a winter migrant. Ripley in the SYNOPSIS mentions it from the Andamans, but adds 'record needs confirmation' (?).

1726. **Monticola solitarius pandoo** (Sykes) (Ghauts, Dukhun) Blue Rock Thrush.

Blyth listed a specimen from the Andamans (1863) and Hume and Davison did not meet it, though one was killed on Ross Island and apparently preserved by the latter. Von Pelzeln is also reported to have obtained a young male at Car Nicobar on 24th February. There do not appear to be any more records, and Ripley (SYNOPSIS) states that the race needs confirmation.

1732. **Zoothera sibirica sibirica** (Pallas) (SE. Transbaicalia) Siberian Ground Thrush.

A single specimen sent by Capt. Hodge to the Asiatic Society of Bengal from Port Blair in March 1860 and described by Blyth as a new species, *inframarginata*, remains the only record (Hume 1874 : 223).

1735. **Zoothera citrina andamanensis** (Walden) (Andamans) Orange-headed Ground Thrush.

1 o? Bakultala, M. A.

This is a great skulker, living in heavy forest. I saw it only on the ground and when disturbed it flew away low and not up into trees as one would expect the Indian birds to do. Butler (1899 : 556) found eight nests, newly built (2), with eggs (4), and young (2) on 16th May, all within a hundred yards of each other. Osmaston (1906a : 160) noted it as common at Port Blair, and found many nests in small trees just outside the forest in May and June. He also noted a 'pretty characteristic song'.

Walden (1874a) when naming the species only says it is different from the Nicobar species, with no description.

1736. **Zoothera citrina albogularis** (Blyth) (Nicobars) Orangeheaded Ground Thrush.

Abbott obtained specimens from Trinkut, Nancowry, Kamorta, and Katchal, where he said they frequented the darkest parts of the jungle, keeping close to the ground.

1762. **Turdus obscurus** Gmelin (Lake Baikal) Dark Thrush.

Blyth (1863) listed a specimen from the Andamans, Butler (1899:555) shot a female on 14th May, and Osmaston (1906a : 160) saw a solitary individual on 4th April. It is a rare straggler to the Andamans only.

1857. **Anthus novaeseelandiae richardi** Vieillot (France) Paddyfield Pipit.

Hume (1874 : 239) found it common in the Andamans in April, securing 7 specimens, and saw it as late as 12th May. He did not see it in the Nicobars. Ripley lists it as a winter visitor to the Andamans. I did not see any pipits.

1863. **Anthus godlewskii** (Taczanowski) (Argun River, South Dauria) Blyth's Pipit.

Walden (1874c : 136) refers to a male obtained in South Andamans on 14th April, which appears to be the only record.

1864. **Anthus cervinus** (Pallas) (Siberia) Redthroated Pipit.

This is a winter visitor to the Andamans and Nicobars where Hume obtained specimens (1874 : 242) ; Osmaston on Barren Island (1908 : 358).

*1874 **Motacilla indica** Gmelin (Malabar) Forest Wagtail.

1 ♀ Wrightmyo, S. A.

A winter visitor to the Andamans. Davison saw it on several occasions singly and in small parties. Osmaston (1906a : 161) noted it as arriving early in October and leaving in April. He refers to its wagging its tail sideways, not up and down as do the other wagtails.

The specimen was shot in heavy forest and I only saw one other, in mangrove.

*1875. **Motacilla flava thunbergi** Billberg (Lapland) Greyheaded Yellow Wagtail.

1 ♀ Choldhari, S. A.

*1876. **Motacilla flava beema** (Sykes) (Dukhun) Blueheaded Yellow Wagtail.

Hume (1874 : 237) secured only 2 specimens of *cinereocapilla* Savi (*borealis* Sundev. =*thunbergi*) but referred to large flocks and 26 specimens of *B. flava* (with pale slaty blue head and conspicuous white supercilium, i.e. *beema*) which he said occurred both in the Andamans and Nicobars. Richmond (1903 : 297) refers to 3 specimens from Trinkut as *flava*.

On 12th February, I saw 3 parties of small birds, which appeared to be yellow wagtails, flying over creek and mangrove at dusk, presumably to roost. The first two were high and consisted of about 200 each, while the latter flew low over the water.

Driving from Bakultala to Betapur on 23rd February, we saw Yellow Wagtails in some numbers in several places.

The single specimen secured on South Andamans on 14th February appears to be *thunbergi*, which is the only form listed for the Andamans in the SYNOPSIS, the Nicobars being completely omitted.

*1884. **Motacilla caspica caspica** (Gmelin) (Caspian Sea) Grey Wagtail.

1 ♀ Car Nicobar: wing 79 mm., tail 73.

I saw several in South Andaman, and Hume (1874 : 237) refers to specimens killed in the first week in September, and on Preparis Island as late as 26 March.

This appears to be a regular but not very common winter visitor.

Motacilla alba subsp. White Wagtail.

Captains Tytler and Beavan saw this species, which is recorded as *M. luzoniensis* Scopoli by Blyth (1863b) and said to be common in cold

weather. Capt. Wimberley (Hume 1876: 291) obtained a specimen at Port Blair in February, but it is not possible to determine its race.

*1903. **Dicaeum concolor virescens** Hume (Neighbourhood of Port Blair) Plaincoloured Flowerpecker.

1 ♂ Wrightmyo, S. A. (wing 47 mm.); 2 ♀♀ Wrightmyo, S. A. (48 mm.), Bakultala, M. A. (46 mm.).

This flowerpecker was frequently seen on *Loranthus* sp. in high trees and also on the flowers of *Sterculia colorata.*

The male shot on 16th February had enlarged testes. Osmaston (1906a: 161) said its note was a sharp click.

*1913. **Nectarinia jugularis andamanica** (Hume) (Andaman Group) Yellowbreasted or Olivebacked Sunbird.

2 oo? Wrightmyo, S. A.; 1 ♂, 1 ♀ Bakultala, M. A. bill 22, 21, 22, 18 from feathers.

Ripley (1961 : 586) has treated the three forms from the Andamans, Car Nicobar, and the Nicobars as subspecies of *jugularis.* While I am unable to comment upon this, it is noteworthy that in this form (*andamanica*), in addition to the larger bills, the males have an off plumage with a dark stripe down the chin as in *N. asiatica* and a plain-coloured forehead (glossy in the others). Ball (1880: 406) noted it at Narcondam.

This sunbird was common in most places attending the flowers of *Loranthus* sp., *Sterculia colorata*, and the drumstick. The male obtained on 22nd February had enlarged gonads.

Butler (1899 : 559) took 2 fresh eggs on 30th May and said the nest was very similar to that of *asiatica.* He also shot breeding birds on 20th January and 7th July.

Osmaston (1906a: 161) said they breed twice in the year, first in February and again in May. The nests were hung from some twig or grass stem, often close to the ground, less frequently at some considerable height up in a shrub or tree.

*1914. **Nectarinia jugularis klossi** (Richmond) (Great Nicobar) Yellowbreasted, or Olivebacked, Sunbird.

1 ♂, 1 ♀ Nancowry : wings 52, 50·5 ; bill 17, 17, from feathers.

During a short visit to Nancowry, Shekar obtained a male and female which are larger than the birds from Car Nicobar and may best be left in this group. The male has the forehead glossy as in *procelia.*

Boden Kloss (1903: 133) refers to several nests of the sunbird (*Arachnothera klossi*) from mangroves overhanging water. These in shape were something like an old-fashioned net purse covered with lichen, and were suspended from the ends of branches. There were two pale brown eggs mottled with a darker pigment in each.

Richmond (loc. cit.) recorded this from Car Nicobar, Trinkut, Tillangchong, Great and Little Nicobar. Birds from Car Nicobar now stand as *procelia.*

*1915. **Nectarinia jugularis procelia** (Oberholser) (Car Nicobar) Yellowbreasted, or Olivebacked, Sunbird.

1 ♂, 1 ♀, Car Nicobar: wings 52, 46 ; bill 15·5, 15·5, from feathers.

This was described as similar to *blanfordi* (now *klossi*) but smaller and with small bill (wing 49, culmen 16·5).

I saw many on Car Nicobar on 7th March, several visiting a patch of small blue flowers hardly a foot off the ground, at the aerodrome, together with *Lonchura striata.*

Davison (1874 : 197) refers to a feeble, twittering, but pleasing little song uttered by males from exposed perches. In this position it is said to slightly open its wings and raise the axillary tufts.

Aethopyga siparaja nicobarica Hume (Kondal) Nicobar Yellowbacked Sunbird.

This form described from specimens taken at Kondal, Nicobar, by Hume (*Stray Feathers* **1** : 412) was again obtained by Abbott and Kloss (Richmond 1903 : 143) in Great and Little Nicobar.

The SYNOPSIS omits this race as also the occurrence of the species in the Nicobars.

[**Arachnothera longirostris** (Latham) (Bengal) Little Spiderhunter.

Tytler believed he saw it, but in the absence of any further records it may be best to omit it from the Andaman list.]

*1936. **Zosterops palpebrosa nicobarica** Blyth (Nicobar) White-eye.

1 ♀ Bakultala, M. A. ; 2 ♂♂ Car Nicobar.

Davison found young in February and Butler (1899 : 390) noted them from both groups of islands, being more common in the Nicobars. Osmaston, (1906a : 156) said they were fairly numerous around Port Blair, where he found them breeding in June and July. I did not see them often. A bird dissected by Blyth (1845 : 536) contained numerous hard black seeds about the size of No. 8 shot. Abbott & Kloss (Richmond 1903 : 288) said it was the commonest bird on Barren Island.

The bills of the specimens obtained are appreciably heavier than of Indian birds, and this, together with the olive-green wash on the upper plumage, shows a greater resemblance to *Zosterops ceylonensis* Holdsworth from Ceylon than to Indian races of *palpebrosa.* Hume (1874 : 242) noticed these characters but thought they were different from those on which Blyth (loc. cit.) had separated the Nicobar birds, describing the upper parts as 'greyish olive-green'. This was interpreted as a 'general lighter colour above' and prompted Richmond (1903 : 288)

to separate the single bird he obtained from Car Nicobar as *Zosterops ventralis*.

***Passer domesticus** subsp. House Sparrow.

2 ♂♂ Port Blair, S. A., 18th March 1964.

This is not mentioned by earlier observers. About half-a-dozen were introduced on Ross Island, Andamans, in 1882 by Mr. O. H. Brookes, who released another 20 in 1895 (Butler, 1899 : 557).

It is now quite common at Port Blair, and I saw it at Choldhari, South Andaman, too. The two specimens obtained are darker chestnut above and have a broader chestnut stripe behind the eye than in Indian birds, and appear very similar to those from Burma, which were at one time accepted as *confucius* Bonaparte. The mail steamer in those days apparently came from Rangoon, and it is not unlikely that birds were brought in from Burma.

[**Passer montanus** from Moulmein was introduced by Tytler (Beavan, 1866 : 419) but, though it appears to have fared better than *P. domesticus* introduced at the same time, there are no subsequent records and it has probably died out.]

*1969. **Lonchura striata fumigata** (Walden) (South Andamans) Whitebacked Munia.

2 ♂♂ Pochang, S. A., Long Island, M. A.; 1 ♀ Long Island, M. A.; 1 o? Bakultala, M. A.

This is restricted to the Andamans, being replaced by another race in the Nicobars. It was noted on both South and Middle Andamans, where I saw them singly, in pairs, and in flocks of about 50. The last was on Long Island, where they visited the same patch of lawn every afternoon, not being seen in the neighbourhood in the mornings, indicating a regular circle of activity.

On 13th February, I saw one making a nest 20 ft. up in a tree, on the edge of a forest. The nest, which was not closely examined, appeared to be more compact than the usual munia's nest seen around Bombay.

Osmaston (1906a : 160) took many nests in June and July.

*1970. **Lonchura striata semistriata** (Hume) (Nicobar Islands) White-backed Munia.

Butler (1899 : 557) said they were common and saw very young birds in August.

Abbott (Richmond 1903 : 297) noted them as common in the islands with open grassland, and did not meet them in the southern islands which are covered with dense forests. I saw them near the aerodrome at Car Nicobar, where they appeared to be common.

[**Estrilda amandava** was also introduced by Tytler at Port Blair, but had disappeared by the time of Hume's visit in 1873.]

[**Lonchura malacca** subsp. Blackheaded Munia.

The only record of this species from this area is Osmaston's, who (1906a : 160) saw three birds at Port Blair, and also noted them building. He did not see them again, nor did anybody else. This was perhaps another instance of an unsuccessful attempt at introduction. The inclusion of this species among the birds listed by B.S. Chengappa in the Working Plan for Middle Andamans Forest Division, 1942-1951, Part II, and based on Bonnington's Census Report 1932, refers in all probability to Osmaston's note.]

2046. **Emberiza aureola aureola** Pallas (Irtysh River, Siberia) Yellow-breasted Bunting.

A single female was shot by Davison in the Nicobars out of a party of about 20, but was blown to pieces (Hume, 1874 : 258). This record is omitted in the SYNOPSIS.

2056. **Emberiza pusilla** Pallas (Transbaikalian Alps) Little Bunting.

Wardlaw Ramsay shot a female on Mt. Harriet, South Andaman, on 28th March (Hume, *Stray Feathers* **2** : 497).

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Colour-vision in Mammals

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(*With six text-figures*)

The capacity of animals to perceive colours in their environment may be considered as a very important biological achievement in the course of the phylogenesis of organisms for, with the appearance of chromatic sensation, animals no longer perceive their environment only grey-in-grey, i.e. they no longer draw visual distinctions merely by differences in light intensity, but also by chromatic qualities—for instance, they distinguish between a red and a green, subjectively equal in light intensity, by their chromatic degree. It is true, we do not know what kind of sensation an animal really has when reacting positively on a wave-length of let us say 690 $m\mu$ (i.e. red). But, as with us any stimulation of the retina by a wave-length of 690 $m\mu$ always runs parallel to the sensation of red, we conclude by analogy that a similar process takes place in animals. Nevertheless, in animals it would be more correct to speak only of ' reaction to certain spectral colours ' instead of ' colour-vision '.

Among all the species of vertebrates colour-perception seems to be least common in mammals. This is very probably due to the fact that most of them are twilight animals, with whom colour-perception would have no practical importance. By adaption to these animals' manner of living the colour-sensitive visual cells of the retina, the cones, were presumably reduced in favour of the cells enabling the vision of light and dark, the rods. This explanation is supported by the fact that the colour-sensitive cones are predominant in the retina of the reptiles, which are poikilothermic and therefore mainly adapted to day-life.

There are mainly three different methods of studying animal colour-perception : the histological, the physiological, and the psychological.

The already mentioned differentiation of the visual cells into cones and rods makes it possible to draw conclusions as to a mammal's ability to see colours from mere histological data. According to the ' duplicity theory ' developed by von Kries, but modified today, the sensorial cells of the retina called rods serve for the vision of light and dark, and the cones for colour-vision. So we may assume that an animal having a certain number of cones in its retina is capable of colour-vision, whereas an animal which has only rods is colour-blind. Histological inquiries,

however, cannot tell us which colours are perceived by animals and what minimum of cones is sufficient for the perception of colours. Furthermore, the light- and colour-sensitive parts of the visual cells, the outer segments of the rods and cones, usually decompose very quickly. As it is just they that show the characteristic differences (whereas the more resistant inner segments are frequently very similar), in many cases only uncertain conclusions can be drawn. According to modern research, some rods are even said to have the nature of cones. So one can easily understand that the conclusions made in scientific writing are often contradictory.

The physiologists, having developed only recently electro-physiological methods of investigation, try to get particulars of colour-vision by stimulating the visual elements by means of coloured light, and recording the electrical currents arising in the layer of the rods and cones or in the visual nerve. The potential oscillations proceeding from the stimulation of the visual cells are shunted by means of very thin electrodes, microelectrodes, which are mostly stuck in the upper layers of the retina. When the diverse groups of visual cells are stimulated by means of light of different wave-lengths, different curves of excitation will result in the area of the primary photochemical processes, i.e. in the layer of the rods and cones, and also in the corresponding nerve-fibres. It was R. Granit (1947) who tried to separate certain tracts, i.e. certain receptors and their corresponding fibres. According to his results, the so-called ' dominators ' react upon a wide wave range with a maximum of about 560 $m\mu$. The so-called modulators, however, are excitable by narrower ranges only. Granit distinguishes between three main kinds of modulators :

1. red-modulators, excitable by wave-lengths between 580 and 600 $m\mu$,
2. green-modulators, excitable by 520 to 540 $m\mu$, and
3. blue-modulators, excitable by 450 to 470 $m\mu$.

The dominators are said to be much more numerous than the modulators. As their curve of stimulation nearly coincides with that of spectral light sensitivity, Granit holds them responsible for sensing light intensity, whereas the modulators are said to govern the colour-sensitiveness of the eye.

At this stage, one could ask whether these electro-physiological methods do not render all the psychological examinations of living animals superfluous. When taking the action potentials of single retinal elements, Granit found a red- and a green-modulator in rats, a blue-modulator in guinea pigs, and, finally, a red-, green-, and blue-modulator in cats. So the existence of a colour-sense seems to be established in these animals. Just rats and cats, however, are commonly denied colour-vision by histologists and psychologists, and a number of authors, who have made electro-physiological experiments themselves, have pointed

out that selective reaction of retinal elements upon certain wave-lengths does not necessarily imply that the central nervous system which receives the impulses, i.e. the brain, is capable of a real distinction of colours. This fact was stressed especially by K. Tansley (1949/50). So histological and electro-physiological methods can only make colour-vision seem probable and, though this probability may be increased where the indications by the two methods tally, no definite answer can be given by them, because all the conditions of colour-vision are not combined in the retina. In fact, the cones and their visual substances provide only the preconditions, on which the data from the nerves and the central nervous system are superimposed.

As we have seen, electro-physiological as well as histological methods still involve factors of uncertainty ; the conclusive position, therefore, must be attributed to psychological inquiry, namely to the training method. In comparison with the two other disciplines the psychologists have the advantage of being able to make varied inquiries with the living animal without inconvenient operations. But it is not easy to get results on the colour-perception of an animal, as the methods usually practised with human beings cannot be applied to animals. Light of different wave-lengths affects physio-electric processes on the retina, of which *we* are subjectively informed through our sensations. In experiments, therefore, *we* make statements about equality or inequality of colour sensations as to colour, quality, and intensity. An *animal*, however, cannot express its sensations in words. So we have to replace direct information by reaction upon particular acquired complexes. By special methods of training, usually taking advantage of the animal's food-impulse, the psychologist tries to attain to as clear a reaction as possible to light of different wave-lengths. Therein, it is most important to prove that an animal does not distinguish the colours merely by differences of light-intensity.

Methods of training in order to investigate the colour-sense of animals have been used since the beginning of this century, but only during the last twenty years have they become an exact experimental science. In older treatises sources of error were not eliminated sufficiently : the abovementioned distinction between chromatic differences and variations in the light intensity was paid no, or at least not enough, regard to, and it was frequently not considered that olfactory impulses, varying structures of the surface of the coloured papers made use of, or other aids given unknowingly (' Lagedressur ') could serve the animal as keys to the solution of its task. In studies of recent date these sources of error are usually attended to. Exact training experiments are carried out in the following manner. An animal is first trained to distinguish a colour and a shade of grey. To eliminate discrimination based only on different light intensity, one has to prove that the animal is able to distinguish the

colour from a large number of greys, e.g. from at least 30 to 60 shades of grey. As at least one of these numerous shades of grey, i.e. intensities of light, would have the same brightness—for the animal's eye—as the colour in question, a confusion at least at this level would be inevitable. Only when an animal is able to distinguish the positive colour from all the shades of grey, can one assume colour-vision.

In most such training experiments coloured papers were used ; in others use was made of monochromatic light. In the former case one can only ascertain whether an animal perceives yellow, green, blue, or red as being something different from grey. The second method is more favourable in so far as the discriminated colours are exactly defined by their wave-lengths, and as the wave-ranges perceived can be marked off more sharply from one another. Indeed, the general statement of colour-perception forms the only basis for an exact analysis. For even if it is established that red, yellow, etc. are being distinguished from all the shades of grey, yet it is not at all certain that the animal is able to differentiate them from one another. For example, an animal tested on one of these colours may be unable to differentiate this colour from the neighbouring colours, thus reducing the number of different colour-ranges perceptible by the animal, as has actually happened with a number of ungulates. On the other hand it must be considered that an incapacity to differentiate between related colours, e.g. red and violet or yellow and green, might also be caused by a bad memory as the animal would have to compare memory-images to sensations. Generally studies concerning animal colour-perception contented themselves with the statement of the ranges perceived, without further delimitation of the ranges differentiated from one another ; so the picture we have concerning the colour-vision of most of the species investigated is still incomplete.

The training methods which have been used are manifold. But, as the invention of exact methods adjusted to the question under investigation and to the animal being experimented on is essential for the acquisition of new biological knowledge, it may be of interest to describe at least a few of the experimental arrangements invented to test colour-vision in animals.

A divergent method, though well adapted to the natural behaviour, for example a cat's play with its prey, was used by C. Buchholtz (1952). She set up an experimental arrangement with mouse-models. One of these models, distinctly coloured, was moved to and fro in front of the cat. In the experiment that followed the animal had to find out this colour from five or six models coloured grey or otherwise. The reward consisted in the fact that the right model was moved by the experimenter immediately after discovery, thus becoming a play-object. If the cat chose wrong, the model would remain motionless, that is to say it was unfit for playing with.

The colour-perception of the ever lively squirrels was recently examined by D. Meyer-Oehme (1957) using Lashley's jumping method. He used discrimination between three simultaneous stimuli involving reward and punishment. The experimental arrangement consisted of a chest, from which the animals had to jump off, and a vertical signal-board with three little doors, which showed the coloured and grey papers. In front of the doors were little landing-boards lying on compressing springs, which were to open the doors automatically as soon as the landing-boards were weighted. If the squirrel jumped right, i.e. to the positive signal, the door would open the way to a feed-box hanging behind the signal-board. If it jumped wrong, the little door would not open.

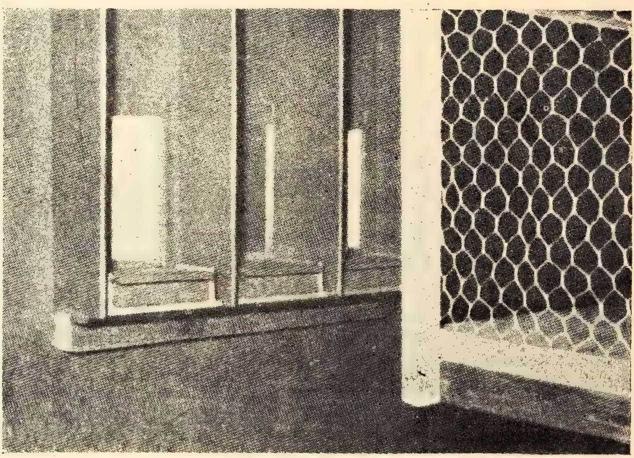

Fig. 1. Choice apparatus used by Meyer-Oehme

To right : Chest surrounded by wire lattice, from where animal had to jump. Left : vertical signal board with 3 little doors showing coloured papers. In front of doors, landing boards.

Very different, too, are some of the methods which have been applied to examine the colour-perception of monkeys. While in most of the experiments the stimulus remains stationary, so that the animal has to move towards it, in the experimental arrangement of W. Koehler (1915) the animals remained in their place and had to draw up the coloured objects by means of a stick, the choice being between two little boxes of different colours. In a later study (1918) Koehler got the animals to point at the boxes and then himself pushed the boxes towards them. Indistinct pointing was not taken notice of, so that the animal was forced to a clear determination.

The Russian (Soviet) woman-scientist N. Kohts (1928) tested the colour-perception of a chimpanzee by discrimination according to certain patterns. The animal was set the task of choosing from a number of coloured objects those that were identical with a pattern shown by the experimenter.

An optomotorical reaction was used by Trincker & Berndt (1959) to verify the colour-perception of guinea pigs. The experimental animals were in a glass cylinder, suspended inside a wider one that rested on a rotating turn-table. The inner surface of the outer cylinder was furnished with vertical alternate strips of grey-coloured paper, making it possible to combine any colour with a number of interchangeable shades of grey. This cylinder was turned round the motionless inner cylinder containing the animals. This method is based upon the fact that a moving object generally causes involuntary motions of the eyes, or also of the head, the eye following the moving object so that the picture on the retina remains the same for some time ; once the turn of the eye has reached a certain degree, however, the eye springs back into its normal position, and a new object is fixed. This changing of the eye with a slow motion in the way of the rotation of the cylinder (1st phase) and a quick one the opposite way (2nd phase) is called ' nystagmus '. When colour-perception is tested in such a rotating cylinder, these movements of the eye naturally appear only if the moving strips are really perceived by the animals. If an animal is not able to discriminate a colour, the subjective intensities of the colour and of at least one of the greys will be equal, and the animal will perceive the inner side of the cylinder as being uniform. Consequently, no nystagmus will ensue, as the moving strips are not differentiated. Unfortunately, this method is not applicable to all the species of mammals. In dogs and monkeys, for instance, the optokinetic nystagmus can be evoked—if at all—only in an imperfect way.

As an example of a more general method I now want to describe an experimental arrangement in detail, which I myself applied on some civets and cats. The testing method was choice between two or three stimuli presented simultaneously with food-reward when the solution was correct. The training took place in the roomy living-cage of the animals. In order to exclude any optical influence from the experimenter, I screened the choosing side of the cage with a black wooden sheet with a square hole in it, through which the choosing field could be watched by means of a mirror. The experimental equipment, which was installed in the cage before the beginning of an experiment, consisted of a cubic choosing-box furnished with a thin wire-lattice at its upper side, and a trap-door separating the box from the cage. Towards this door the experimental animal was led by two wooden plates that were arranged in the manner of an eel-basket. Through the wire-lattice of the trap-door the animal could already perceive the coloured papers on the choosing apparatus,

which was centrally lighted from above, before the door was opened (Fig. 2). The actual choosing arrangement itself consisted of two square

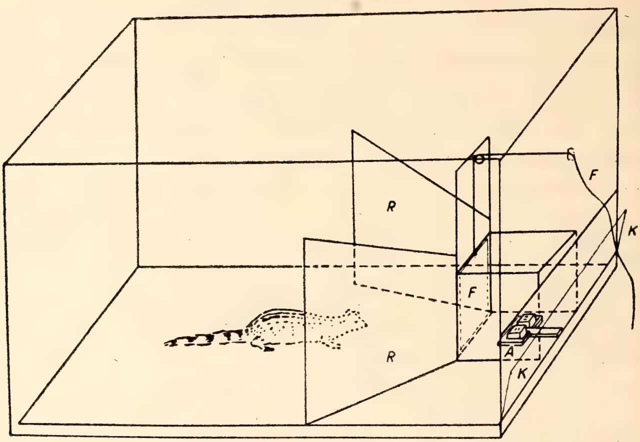

Fig. 2. Arrangement used in author's experiments

A = choice apparatus, F = trap-door between box and cage. The animal was led towards trap-door by two wooden plates (= R) arranged in the manner of an eel-basket. K = a door which can be opened to put choice apparatus into box.

feeding-dishes fixed on a stalked board, which could be covered up with two wooden tablets of equal size. The tablets, that had to be removed by the animals, were lined with standardized coloured or grey pigmented papers. As a grey-series I used a series of 60 shades from white to black. To exclude secondary keys to the solution, for instance varying structure of surface of the papers or scents of colour, I covered the coloured papers with wax. During the training the negative food container also contained food, kept out of reach under a lattice of gauze, and so no training on olfactory stimuli could take place. In the tests both sides were supplied with attainable food. To prevent a training according to position the colour was placed on the right or on the left in random succession. If the animals were able to discriminate the positive colour from numerous shades of grey, that is to say if they always opened the food container covered with the coloured lid, I was allowed to assume that they had really distinguished the colour from the greys.

The training proceeded as follows: First, the animals were trained upon a certain colour contrasting with *black*. A mongoose for instance learned to discriminate green from black after 500 trials. In the following test the positive colour remained constant while the black

was being replaced by grey becoming gradually lighter and lighter up to white. Every shade of grey was presented 50 times, always contrasting with the colour. A task was considered as being mastered if the percentage of correct choice was 80 % at least. In this way I was able to show good colour-perception in mongooses but not in civets, genets, and domestic cats. The following diagram (Fig. 3) may serve as an example of the interpretation of tests like these.

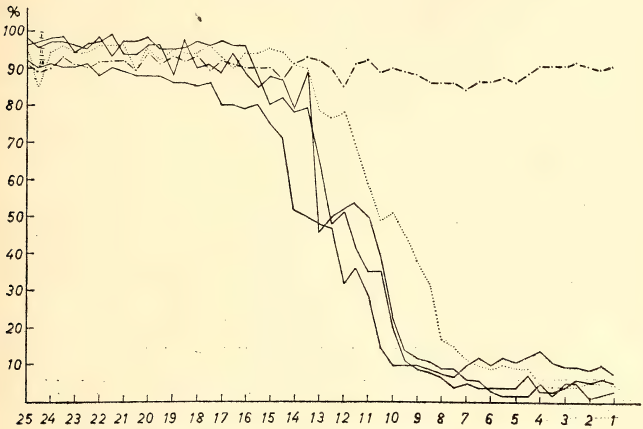

Fig. 3. Results of tests : discrimination of blue from grey

——— = domestic cats ; ········ = *Viverricula malaccensis* ; -·-·-·- = *Herpestes edwardsi*. Abscissa : types of grey from dark (25) to white (1). Ordinate : percentage of right choice.

The diagram shows that only the mongoose was able to discriminate the colour (here blue) from all degrees of grey. The curve of the mongoose nearly remains constant ; this means that the animal always discriminated the colour from all the greys at a percentage of 85 to 95. The curves of the civet and the cats, however, fall as soon as the colour is contrasted with lighter shades of grey. The conclusion is that, with grey having the same subjective light intensity as the colour, these animals totally confounded the colour with the grey. Only about 50 % of the choices were correct ; so we must say they were only casual. It is interesting to see that after a zone of confusion the curves go on falling. This means that the animals had not at all perceived and learned the colour, but only the light intensity, and they had only responded to the relation of light and dark. Once the grey was distinctly brighter than the offered colour, cats and civets now chose the grey. When trained upon yellow the animals behaved similarly. With the civets, however, I got

different results when I trained them on green (Fig. 4) and red (Fig. 5). As before there are shades of grey which are confounded with the colours, but the curve rises again after the zone of confusion. Moreover, in

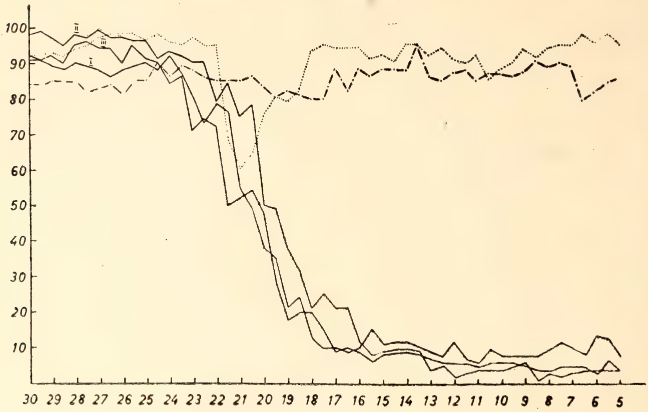

Fig. 4. Test-results : discrimination of green from grey

——— = domestic cats ; ········ = *Viverricula malaccensis* ; ·–·–·–· = *Herpestes edwardsi*. Abscissa : types of grey from dark (30) to light grey (5). Ordinate : percentage of right choices.

Fig. 5. Test-results : discrimination of red from different types of grey

this range the values are still about 60%. To test whether the previous confusion was caused by an incapacity to differentiate the colours from certain shades of grey, and whether there had taken place a choice according to *absolute* light intensity before, I now trained some civets on red and green contrasting with the greys which had caused confusion. In the course of the training I noticed slow improvement of the animals' power of discrimination (Fig. 6). So we may assume that civets do perceive red and green as colours and that they made a qualitative distinction

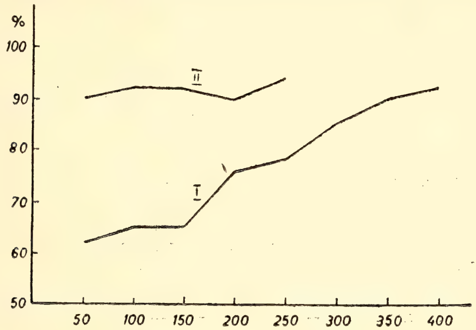

Fig. 6. Learning curve and Test-result of *Viverricula*: discrimination of red from grey

I. Learning curve. The animal was trained on red contrasting with grey of a light intensity which had formerly caused confusion. II. Test-result: discrimination of red and a second level of grey which had also been confounded. Abscissa: number of trials.

in the tests. But the colour-sense seems to be only little developed. The primary orientation seems to take place according to light intensities; later, when the experimental series are continued, more notice is taken of the colour element. So the results vary very much with individual animals.

Which mammals have now been tested with respect to their colour-perception up to now, and what were the results of these inquiries? I am going to answer these questions by giving a survey beginning with the more primitive groups and ascending to the higher ones (Table at pp. 582 & 583). The marsupials and insectivora have been only very little taken in consideration hitherto. Among the former only the opossum (*Didelphis virginiana*) has been inquired into. It is safe to say that this animal is incapable of chromatic sensation. With the hedgehog (*Erinaceus europaeus*) a positive result was yielded with regard to yellow, but not with blue; other colours were not examined.

TABLE

COLOUR-VISION IN MAMMALS WHICH HAVE BEEN TESTED UP TO NOW : RESULTS ARRIVED AT BY TRAINING METHOD

Note : + = the animal can perceive the colour ; — = the animal is incapable of this chromatic sensation ; (+) = results are contradictory but probably the animal has a colour sense ; (—) = results are contradictory but most authors deny colour-vision ; ? = this colour has not been examined.

Tested Animals	Red	Orange	Yellow	Green	Blue	Violet	Notes
MARSUPIALIA							
Opossum (*Didelphis virginiana*)	—	?	—	—	—	?	
INSECTIVORA							
Hedgehog (*Erinaceus europaeus*)	?	?	+	?	—	?	
RODENTIA							
Rat (*Rattus norvegicus*)	(—)	?	(—)	(—)	(—)	?	
House-mouse (*Mus musculus*)	(—)	?	(—)	(—)	(—)	?	
Wood-mouse (*Apodemus sylvaticus*)	—	?	—	—	—	?	
Vole (*Clethrionomys glareolus*)	+	?	+	—	—	?	
Golden hamster (*Mesocricetus auratus*)	—	?	—	—	—	?	
Guinea pig (*Cavia cobaya*)	+	?	+	+	+	?	
Squirrel (*Sciurus vulgaris*)	+	?	+	+	+	?	
Ground squirrel (*Citellus citellus*)	?	+	+	+	+	?	
LAGOMORPHA							
Rabbit (*Oryctolagus cuniculus*)	(—)	?	(—)	(—)	(—)	?	
CARNIVORA							
Polecat (*Putorius putorius*)	+	?	+	+	+	?	But only less sensitive to green and yellow.
Mink (*Putorius lutreola*)	+	?	—	+	—	?	Reaction on yellow and blue less unequivocal.
Pine-Marten (*Martes martes*)	—	?	—	—	+	?	
Ferret (*Putorius furo*)	+	?	—	—	—	?	Only little sensitive to red.
Stoat (*Mustela erminea*)	+	?	+	+	+	?	
Raccoon (*Procyon lotor*)	—	—	—	—	—	—	

Tested Animals	Red	Orange	Yellow	Green	Blue	Violet	Notes
Dog (*Canis familiaris*)	(+)	?	(+)	(+)	(+)	?	Limited colour sense. Primary orientation to differences in intensity, but training on colours is at least possible.
Cat (*Felis domesticus*)	(—)	(—)	(—)	(—)	(—)		Results are contradictory but most of the authors deny colour vision.
Civet-cat (*Viverricula malaccensis*)	+	?	—	+	—	?	
Mongoose (*Herpestes edwardsi*)	+	+	+	+	+	+	
Genet (*Genetta tigrina*)	—	?	—	—	—	?	
UNGULATA							
Horse (*Equus caballus*)	+	?	+	+	+	?	
Zebu	+	+	+	+	+	+	Cannot distinguish orange, yellow, and green from one another.
Sheep	+	?	+	?	+	?	
Dwarf-goat (*Capra hircus*)	+	+	+	+	+	+	Distinguishes only 3 colour regions: 1. violet through red up to yellow, 2. yellowish green to green, 3. blue.
Red deer (*Cervus elaphus*)	+	+	+	+	+	+	Cannot distinguish red from violet.
Antelope (*Boselaphus tragocamelus*)	+	+	+	—	—	?	
Giraffe (*Giraffa camelopardalis*)	+	+	+	+	+	+	Cannot distinguish red, orange, and yellow from one another.
PRIMATES							
Tupaya (*Tupaia glis*)	+	?	+	+	+	?	
Rhesus (*Macaca mulatta*)	+	+	+	+	+	+	
Pigtailed macaque (*Macaca nemestrina*)	+	+	+	+	+	+	
Baboon (*Papio papio*)	+	+	+	+	+	+	
Longtailed macaque (*Pithecus fascicularis*)	+	+	+	+	+	+	
Longtailed monkey (*Cercopithecus callitrichus*)	+	+	+	+	+	+	
Capuchin monkey (*Cebus apella*)	—	+	+	+	+	+	
Spider monkey (*Ateles*)	—	+	+	+	+	+	
Gibbon (*Hylobates lar*)	+	?	+	+	+	?	
Chimpanzee (*Pan troglodytes*)	+	+	+	+	+	+	
Orang-Utan (*Pongo pygmaeus*)	+	?	+	+	+	?	

The greatest number of such studies is concerned with rodents, especially rats and mice. In spite of some contradictory results colour-vision seems to be lacking in rats, white and grey house-mice, and wood-mice (*Apodemus sylvaticus*). Voles (*Clethrionomys glareolus*), however, could be trained on red and yellow though not on green and blue. Generally speaking, those rodents which have only a feeble sense of colour seem to be able to discriminate long wave-lengths at the most. With regard to golden hamsters (*Mesocricetus auratus*) no colour-perception could be traced by means of the training method, whereas the diurnal guinea pigs (*Cavia cobaya*) and squirrels (*Sciurus vulgaris*) have a well-developed sense of colour. They are able to discriminate yellow, green, red, and blue from numerous shades of grey. Only when a colour was contrasting with another colour squirrels had in the beginning difficulties in differentiating yellow from a yellowish green. In recent studies the ground-squirrel (*Citellus citellus*), too, proved itself capable of colour-vision.

As for the lagomorphs there are studies on the colour-vision of rabbits (*Oryctolagus cuniculus*), the result being negative.

We know very little, too, about the colour-vision of many carnivores. Taking into account the nocturnal life of most of them, for a long time all the species of this order of mammals were considered as achromates. But it appeared that some of them have a marked power of colour-perception. Among the mustelids, polecats and martens are colour-blind according to older studies, but later a perception of at least some colours was traced in other mustelids, and also in a polecat (*Putorius putorius*) that could be trained on the four primary colours, though it proved less sensitive to green and yellow. A mink (*Putorius lutreola*), on the contrary, was sensitive to red and green, whereas yellow and blue were reacted upon less unequivocally. The pine-marten (*Martes martes*) perceives only blue as a chromatic quality, and is blind to red, yellow, and green. The ferret (*Putorius furo*), on the other hand, is only little sensitive to red, and blind to yellow, green, and blue. The stoat (*Mustela erminea*) perceives all the primary colours, whereas raccoons (*Procyon lotor*) are totally colour-blind. Dogs (*Canis familiaris*) have been tested most frequently. Although here, too, the results of the experiments are often contradictory, one may assume that dogs do have a limited colour-sense. Nevertheless, it is not impossible that different races of dogs behave differently.

House-cats (*Felis domesticus*) have been tested by numerous authors, with greatly varying results. Yet most of the authors, and myself, deny a colour-perception in cats, or they think it possible that their colour-sense is developed so poorly that it is hardly ever traceable with certainty.

With regard to viverrids, in my experiments a small civet (*Viverricula malaccensis*) proved to be blind to yellow and blue ; a positive result was

obtained only with red and green. In addition to the four primary colours, an Indian mongoose (*Herpestes edwardsi*) was able to discriminate orange and violet from all the shades of grey, even those of equal light-intensity. When I offered colours only, difficulties arose in discriminating between red and violet, red and orange, green and blue, and violet and blue. Genets (*Genetta tigrina*) are totally colour-blind.

Among the ungulates horses (*Equus caballus*) recognized yellow, green, and blue by their chromatic qualities, whereas the training on red was difficult. It was similar with a zebu, but it confounded some colours, namely green, yellow, and orange with one another. Sheep were tested only with respect to the colours red, yellow, and blue. The result was positive. A Nilgai antelope (*Boselaphus tragocamelus*) performed its training tasks correctly only with respect to yellowish green, yellow, orange, and red ; green and blue were both mistaken for a number of greys. A female red deer (*Cervus elaphus*) learnt to discriminate the four primary colours from grey ; when offered colours only she succeeded in differentiating the ranges from violet to red, orange to yellow, and yellowish green to green and blue. A dwarf-goat (*Capra hircus*) was not able to differentiate violet and red, red and yellow, yellowish green and green from one another, though it discriminated any of these colours from all the greys. Finally, giraffes (*Giraffa camelopardalis*) cannot distinguish, one from another, red, orange, and yellow, which are obviously perceived as one homogeneous chromatic range. But they, too, proved able to recognize all the colours when contrasting with numerous greys. In general one may say that in ungulates the capacity to discriminate colours from one another is rather limited.

With respect to our own colour-sense that of the monkeys is of special interest. A number of prosimiae, as for instance the lemurs, are totally colour-blind, but Tupaias, which are not nocturnal have a well-developed colour-sense. Among the catarrhine group the rhesuses (*Macaca mulatta*), pig-tailed macaques (*Macaca nemestrina*), baboons (*Papio papio*), long-tailed macaques (*Pithecus fascicularis*), and long-tailed monkeys (*Cercopithecus callitrichus*) have a fully developed trichromatic colour sense like human beings, though a certain under-sensitiveness to red was traceable in baboons and rhesuses. The platyrrhine group, on the contrary, namely the species *Cebus* (capuchin monkey) and *Ateles* (spider monkey) are dichromates. Especially with capuchin monkeys the experiments proved red-blindness.

A slightly reduced sensitiveness to red was found in chimpanzees, too ; yet there is no valid reason to speak of a decrease in the trichromatic system. In fact, according to other studies, chimpanzees are said to perceive the long-wave end of the spectrum even a little further than normal-sighted human beings. Orang-utans and gibbons (*Hylobates ar*) are also capable of colour-vision.

According to the results of experiments with monkeys made hitherto the catarrhine group obviously holds an intermediate position between the dichromatic platyrrhines and the trichromatic human beings. They generally show a slight tendency towards protanopy.

Considering once more most of the results we find colour-vision in representatives of various orders, in phylogenetically low groups as well as in higher ones. Its state of development is highest with the highest species of monkeys. Yet colour-vision could be proved with certainty in such animals only as are predominantly diurnal. The majority of the nocturnal animals proved to be colour-blind.

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The Flora of Hare and Church Islands off Tuticorin

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(*With a map*)

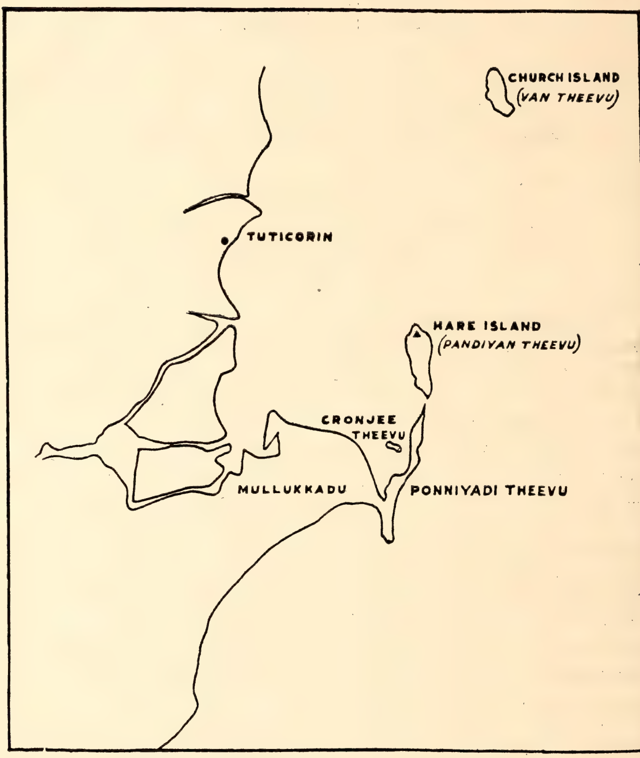
(*Communicated by the Dean, Agricultural College & Research Institute, Coimbatore*)

There are at least nine well-known islands situated in the Gulf of Mannar, off Tuticorin coast, which lie at lat. 8°48′ N. and long. 78°11′ E. These are locally known as Upputhanni Theevu (Salt-water Island), Nallathanni Theevu (Fresh-water Island), Shuli Theevu, Karia Shuli Theevu, Vilangu Shuli Theevu, Koswari Theevu, Cronjee Theevu, Van Theevu (Church Island), and Pandiyan Theevu (Hare Island or Lighthouse Island). All these islands are situated within a radius of about 22 kilometres from Tuticorin port; of them Hare Island and Church Island are situated at 4·5 and 6·5 kilometres respectively. Hare Island has about 58·85 hectares (143·5 a. or 0·22 sq. mile) of land while Church Island has about 22 hectares (52·4 a. or 0·08 sq.mile) of land. All these islands appear to be the eroded relics of a once existent continent or vast stretch of land which subsided into the sea in the hoary past. Even now at least some of them are said to be subsiding at an imperceptibly slow rate, as is evidenced by the submersion of the once existent church, of which the tower alone is now visible.

Pandiyan Theevu or Hare 'Island', the bigger of the two, is also known as Lighthouse Island due to the presence of a lighthouse at its northern extremity. It is connected with the mainland by a narrow neck of land which is submerged on occasions when there are very high tides. Church Island which lies to the north of Hare Island is really an island and is surrounded by sea several fathoms deep.

Church Island is not inhabited. Fishermen and *kunkur*-stone gatherers occasionally visit the island. Due to the exposed nature of this small island there is no tree growth and so it does not afford any opportunity for fuel gatherers. As such the vegetation of this island can be deemed to be a natural one not interfered with by either man or cattle.

Hare Island has a lighthouse, and an official in charge of the lighthouse lives near the northern extremity of the island. Further, since the island is more or less continually joined with the mainland by



Hare and Church Islands and the near-by coast

a narrow isthmus, grazing animals are often found on it. Also, fuel gatherers and *kunkur*-stone cutters make frequent visits. These biotic factors influence the composition of the vegetation.

The soil of Church Island is mainly sandy. The main soil-type in Hare Island is sandy loam. The whole of the coastal belt on the east and on the northern narrow strip carries sand which rises in small dunes, affected by wind, resulting in shifting of the sand wherever there is sparse vegetation. The south-western depressed portion of the island has calcareous rocks exposed by the waves of the sea with the

calcareous stones and soil extending some distance into the island. The southern region which is connected with the mainland by a very narrow isthmus has low-lying saltflats interposed here and there with small pockets of depressions wherein it is marshy.

The average rainfall is nearly 94 cm. and the major portion of the rain is received during the NE. monsoon. The rains are heavy usually in the months of October-November. The hottest part of the year is from April to September though, with the strengthening of the monsoon on the west coast of India, a few drizzles are received in July. The maximum temperature ranges from 28° to 39°C. and the minimum temperature from 20° to 25°C. The islands are exposed to strong winds during June-July with the wind moving from the south-westerly direction.

These islands were visited in May 1944, February 1945, January 1957, and the last survey was conducted during May 1961. The aspects and composition of the natural vegetation in the two islands are presented in this paper.

We are thankful to the various officers of the Fisheries Department and the Port Officials at Tuticorin who gave us all facilities and help during the various visits to the above islands. The authors are also thankful to Dr. Sebastine, Systematic Botanist, Botanical Survey of India, Southern Circle, Coimbatore, who has very kindly gone through the manuscript and has given valuable suggestions for improvement.

General aspect and composition of vegetation

i. *Church Island.* The vegetation of Church Island has been recorded by Srinivasan (1960, *J. Bombay nat. Hist. Soc.* **57** : 348-353), who has listed 28 species representing 13 families. In the surveys conducted by the present authors, 54 species representing 46 genera and 24 families have been collected. An account of the aspects not covered by Srinivasan is given here.

The shallow submerged littoral region carries aquatic species of *Halophila ovata* Gaud., *Ruppia maritima* Linn., and *Cymodocea serrulata* Aschers. & Magn. in mixed population. The foreshore is clothed with extensive formations of *Sesuvium portulacastrum* Linn. along with *Suaeda fruticosa* Forsk. and *S. monoica* Forsk. These form a continuous belt of nearly three to four metres width. Occasionally a pure community of *Sesuvium portulacastrum* Linn. is met with towards the water-line along with *Arthrocnemum indicum* Moq. and *Salicornia brachiata* Roxb. It was interesting to note a single circular patch of *Opuntia dillenii* Haw. in this belt extending over three metres in diameter. Along the periphery of this patch towards the interior side a few clumps of *Aloë barbadensis* Mill. were also noticed. Abutting the *Suaeda-Sesuvium* belt in the interior were the associated plant communities of tall *Cyperus*

pachyrrhizus Nees and *Halopyrum mucronatum* Stapf. The continuity of this plant belt is interrupted here and there by *Dichrostachys cinerea* W. & A., *Acacia planifrons* W. & A., *A. latronum* Willd., *Zizyphus mauritiana* Lamk., and *Scaevola plumieri* Vahl with *Oldenlandia umbellata* Linn. and *Enicostemma hyssopifolium* (Willd.) Verdoorn forming the lower tier of vegetation. The *Cyperus-Halopyrum* association is followed towards the interior of the island by the formation of *Cymbopogon caesius* (Nees) Stapf, *Dichanthium annulatum* (Forsk.) Stapf, and *Aristida depressa* Retz. *Cyperus arenarius* Retz. and *Bulbostylis barbata* Kunth were found to occur along the periphery of the *Cymbopogon-Dichanthium-Aristida* belt. This belt is broken here and there by the inroading of species like *Cenchrus ciliaris* Linn., *C. ciliaris* var. *echioides* Hook. f., *Striga asiatica* (Linn.) O. Kuntze, *S. euphrasioides* Benth., *Crotalaria verrucosa* Linn., *Phaseolus trilobus* Ait., *Indigofera oblongifolia* Forsk., and *Tephrosia purpurea* Pers. which, excepting *Striga asiatica* (Linn.) O. Kuntze and *S. euphrasioides* Benth., occupy the rest of the area of the island. The sand mounds which lie scattered in the vicinity of this region are all covered by the associated species of *Spinifex littoreus* (Burm. f.) Merr., *Ipomoea pes-caprae* (Linn.) Sweet, and *Launaea sarmentosa* (Willd.) Alston. In the damp low-lying areas of the interior of the island were seen extensive but open formations of *Atriplex stocksii* Boiss. alternating with *Coelachyrum lagopoides* (Burm.f.) Senaratna, *Sporobolus elongatus* R.Br., and *S. marginatus* Hochst. ex A. Rich. Sparse but widely occurring species were *Chloris inflata* Link., *Aerva lanata* Juss., *Phyllanthus maderaspatensis* Linn., and *Gisekia pharnaceoides* Linn. In the central portion widely scattered thickets of *Indigofera oblongifolia* Forsk., *I. viscosa* Lamk., and *Clerodendrum inerme* Gaertn. have been noticed. The herbaceous species found to occur densely in this area was *Enicostemma hyssopifolium* (Willd.) Verdoorn. A noteworthy feature in the vegetation of this area is the occurrence of small patches of *Crotalaria verrucosa* Linn. which produces unusually long (about 2 to 2½ feet) dense inflorescences.

ii. *Hare Island.* Hare Island or Lighthouse Island (Pandiyan Theevu) exhibits a peculiar type of vegetation usually met with in scrub jungles found on the east coast of south India. Species like *Commiphora berryi* (Arn.) Engl., *Zizyphus mauritiana* Lamk., *Dodonaea viscosa* Linn., *Lannea coromandelica* (Houtt.) Merr., *Cassia auriculata* Lamk., *Dichrostachys cinerea* W. & A., *Acacia planifrons* W. & A., *A. latronum* Willd., *Achyranthes aspera* Linn., *Aerva lanata* Juss., *A. javanica* (Burm. f.) Spr., *Cissus quadrangularis* Linn., *Polygala chinensis* Linn., *Borreria hispida* (Linn.) K. Schum., *Abutilon indicum* G.Don, *Jatropha glandulifera* Roxb., *Coccinia cordifolia* (Linn.) Cogn., *Dichanthium annulatum* (Forsk.) Stapf, and *Chloris inflata* Link. which constitute this type of vegetation have been found to occur scattered all over

the island. The other arboreal species recorded in the island are *Thespesia populnea* Cav., and the recent arrival *Prosopis juliflora* DC.

Among the herbaceous species which constitute the bulk of the vegetation of this island *Crotalaria verrucosa* Linn., *Phaseolus trilobus* Ait., *Blumea obliqua* (Linn.) Druce, *Vernonia cinerea* Less., *Oldenlandia umbellata* Linn., *Cassia auriculata* Lamk., *Portulaca tuberosa* Roxb., *Polygala chinensis* Linn., *Aerva lanata* Juss., *A. javanica* (Burm.f.) Spr., *Glinus oppositifolius* (Linn.) A.DC., *Justicia tranquebariensis* Linn.f., and *Boerhavia diffusa* Linn. preponderate over the rest of the species seen in Church Island. The submerged aquatics of the foreshore were constituted by *Halophila ovata* Gaud., *Ruppia maritima* Linn., and *Cymodocea serrulata* Aschers. & Magn.

On the sandy beaches *Aloë barbadensis* Mill. was found to occur in isolated patches. A little interior to this region good specimens of *Salvadora persica* Linn. were found to occur. The bulk of the tussocks were formed by *Cenchrus ciliaris* Linn., its variety *echioides* Hook f., *C. setigerus* Vahl, and *Cymbopogon caesius* Stapf. Among the other species constituting the grass flora of the island *Coelachyrum lagopoides* (Burm.f.) Senaratna, *Halopyrum mucronatum* Stapf, *Sporobolus elongatus* R.Br., and *S. marginatus* Hochst. ex A.Rich. are worth mentioning. On the sand mounds were seen dense thickets of *Clerodendrum inerme* Gaertn. The other species associated with sand mounds were *Spinifex littoreus* (Burm.f.) Merr. and *Ipomoea pes-caprae* (Linn.) Sweet. The occurrence of *Gloriosa superba* Linn., *Cyanotis axillaris* Roem. & Schult., *Tribulus terrestris* Linn., *Pupalia lappacea* Moq., and *Rhynchosia minima* DC. is a noteworthy feature. Among the species of *Indigofera* found on this island *Indigofera articulata* Gouan formed a pure formation on an elevated land in the isthmus which connects this island with the mainland. The most striking aspect of the vegetation of the island is the concentration of the halophytes only in the aforesaid isthmus which is not infrequently submerged by the tidal waters. The composition of this type of vegetation though not altogether different from the species met with on Church Island is yet characterised by the unique occurrence of *Avicennia officinalis* Linn.

Vegetation of Hare Island and Church Island compared

The composition of the vegetation of both the islands on comparison brings out certain distinctive features which are common to both the islands or specific only to Hare Island. These distinctive features are influenced to a greater extent by their situation, the edaphic and environmental factors. Thus it may be seen in Church Island which is isolated farther from the mainland and surrounded by sea, owing to the constant windswept nature, the flora consists chiefly of low shrubs,

herbaceous perennials and annuals, grasses and sedges. Nowhere in the island does one come across any arboreal species approaching even two metre height. The bulk of the vegetation in Church Island is composed of the tussock-forming grass species and sedges and their distinct associations into well-defined communities is a striking feature. Among the twenty-four families representing the flora of Church Island, Gramineae and Leguminosae are by far the most represented families followed by the halophytic members of Chenopodiaceae.

Among the thirty-seven families constituting the floristic regions of Hare Island the members of Gramineae, Leguminosae, Amaranthaceae, Cyperaceae, Compositae, and Chenopodiaceae predominate. The families like Capparidaceae, Burseraceae, Sapindaceae, Anacardiaceae, Cucurbitaceae, Boraginaceae, Solanaceae, Acanthaceae, and Commelinaceae present in Hare Island are characteristically absent from Church Island.

Hare Island, because of its close proximity to the mainland, has perhaps the same conditions of soil favouring the growth of the arboreal species and herbaceous perennials and annuals commonly met with in the regions of the mainland adjoining the sea-coast. Thus one comes across species like *Thespesia populnea* Cav., *Prosopis juliflora* DC., *Jatropha glandulifera* Roxb., and *Solanum surattense* Burm. in Hare Island but they are not found in Church Island. Even *Salvadora persica* Linn., which is common in both the islands, grows to a very small tree in Hare Island, whereas in Church Island it was less than even ten metres in height. The pure and extensive formation of *Scaevola plumieri* Vahl, *Clerodendrum inerme* Gaertn., and *Indigofera articulata* Gouan in Hare Island is a noteworthy feature.

Species of possible economic exploitation

The flora of the islands brings out certain species which are of potential economic importance and which could be exploited for use. *Crotalaria verrucosa* Linn., the papilionaceous plant with very good growth under saline sandy conditions in Church Island, is likely to be a good green manure plant for such areas on the coastal belt. The occurrence of *Indigofera articulata* Gouan with luscious growth in Hare Island is a pointer towards its utilization as another green manure plant for saline or sandy areas. *Tephrosia purpurea* Pers. and *Indigofera oblongifolia* Forsk. are two other leguminous plants which are commonly found in these islands.

Cenchrus ciliaris Linn., *C. ciliaris* var. *echioides* Hook.f., *Cenchrus setigerus* Vahl, *Sporobolus elongatus* R.Br., *S. marginatus* Hochst. ex A. Rich., *S. tremulus* Kunth, and *Dichanthium annulatum* (Forsk.) Stapf are the species of grasses which are found in these islands. These are

good and highly palatable to animals. *Cenchrus ciliaris* var. *echioides* Hook.f. is particularly suited for the sandy loams, and *Sporobolus virginicus* Kunth, *S. elongatus* R.Br., and *S. marginatus* Hochst. ex A. Rich. for the saline sandy areas. It is of interest that the species *Phaseolus trilobus* Ait. occurs very commonly throughout these two islands and has good vegetative spread. This appears to be an eco-type with smaller leaves, water marks on the leaflets, and also deeper lobing of the leaflets. It is possible that this eco-type could be made use of as a pasture legume. The islands abound with a few medicinal plants, especially *Enicostemma hyssopifolium* (Willd.) Verdoorn, *Aloë barbadensis* Mill., *Oldenlandia umbellata* Linn., *Cassia angustifolia* Vahl, and *Citrullus colocynthis* Schrad.

Enumeration

Capparidaceae

Gynandropsis gynandra (Linn.) Briq.
Common, only in Hare Island, in flower and fruit. (20-1-57 ; 18-5-61).

Polygalaceae

Polygala chinensis Linn.
Common, only in Hare Island. (20-1-57 ; 18-5-61).

Portulacaceae

Portulaca tuberosa Roxb.
Common, in both the islands. (17, 18-5-61).

Malvaceae

Abutilon indicum G.Don.
Common, only in Hare Island, in flower and fruit. (20-1-57 ; 18-5-61).

Pavonia odorata Willd.
Few, only in Hare Island, in flower and fruit. (20-1-57 ; 18-5-61).

Thespesia populnea Cav.
Common, only in Hare Island, in flower. (20-1-57 ; 18-5-61).

Sterculiaceae

Melochia corchorifolia Linn.
Few, only in Hare Island, in flower. (20-1-57 ; 18-5-61).

Tiliaceae

Corchorus aestuans Linn. non Forsk.

Few, in both the islands, in flower and fruit. (20-1-57; 17, 18-5-61).

Zygophyllaceae

Tribulus terrestris Linn.

Common, only in Hare Island, in flower and fruit. (20-1-57 ; 18-5-61).

Burseraceae

Commiphora berryi (Arn.) Engl.

Common, only in Hare Island, on sand mounds, in flower and fruit. (20-1-57 ; 18-5-61).

Rhamnaceae

Zizyphus mauritiana Lamk.

Common, in both the islands, in flower and fruit. (20-1-57 ; 17, 18-5-61).

Vitaceae (=Ampelideae B.H.)

Cissus quadrangularis Linn.

Common, in both the islands. (17, 18-5-61).

Sapindaceae

Dodonaea viscosa Linn.

Few, only in Hare Island. (20-1-57 ; 18-5-61).

Anacardiaceae

Lannea coromandelica (Houtt.) Merr.

Few, only in Hare Island. (20-1-57 ; 18-5-61).

Leguminosae (Lotoideae)

Crotalaria verrucosa Linn.

Common, in both the islands, in flower and fruit. (20-1-57 ; 17, 18-5-61).

Indigofera oblongifolia Forsk.

Common, in both the islands, in flower and fruit. (8-2-45 ; 20-1-57 ; 17, 18-5-61).

Indigofera viscosa Lamk.

Common, in both the islands, in flower and fruit. (8-2-45 ; 20-1-57 ; 17, 18-5-61).

I. articulata Gouan

Common, only in Hare Island, in flower and fruit. (20-1-57 ; 18-5-61).

Tephrosia hirta Ham.

Few, only in Hare Island, in flower and fruit. (20-1-57 ; 18-5-61).

Tephrosia purpurea Pers.

Common, in both the islands, in flower and fruit. (8-2-45 ; 20-1-57 ; 17, 18-5-61).

Phaseolus trilobus Ait.

Common, in both the islands, in flower and fruit. (20-1-57 ; 17, 18-5-61).

Rhynchosia minima DC.

Common, only in Hare Island, in flower and fruit. (20-1-57 ; 18-5-61).

LEGUMINOSAE (CAESALPINIOIDEAE)

Cassia auriculata Linn.

Common, in both the islands, in flower and fruit. (20-1-57 ; 17, 18-5-61).

C. angustifolia Vahl

Common, only in Hare Island, in flower and fruit. (20-1-57 ; 18-5-61).

LEGUMINOSAE (MIMOSOIDEAE)

Dichrostachys cinerea W. & A.

Common, in both the islands, in flower and fruit. (17, 18-5-61).

Acacia planifrons W. & A.

Common, in both the islands, in flower and fruit. (17, 18-5-61).

A. latronum Willd.

Common, in both the islands, in flower and fruit. (17, 18-5-61).

Prosopis juliflora DC.

Common, only in Hare Island, in flower and fruit. (18-5-61).

CUCURBITACEAE

Cucumis melo Linn. var. **agrestis** Naud.
Common, only in Hare Island. (20-1-57 ; 18-5-61).

Citrullus colocynthis Schrad.
Common, only in Hare Island. (20-1-57 ; 18-5-61).

Coccinia cordifolia (Linn.) Cogn.
Few, only in Hare Island. (20-1-57 ; 18-5-61).

Corallocarpus epigaeus Hook. f.
Common, only in Hare Island. (20-1-57).

CACTACEAE

Opuntia dillenii Haw.
Common, in both the islands, in flower and fruit. (17, 18-5-61).

AIZOACEAE (=FICOIDEAE B.H.)

Sesuvium portulacastrum Linn.
Common, in both the islands, in flower. (20-1-57 ; 17, 18-5-61).

Glinus oppositifolius (Linn.) A.DC.
Common, only in Hare Island, in flower. (17, 18-5-61).

Gisekia pharnaceoides Linn.
Common, in both the islands. (17, 18-5-61).

RUBIACEAE

Oldenlandia umbellata Linn.
Common, in both the islands, in flower and fruit. (8-2-45 ; 20-1-57 ; 17, 18-5-61).

Borreria hispida (Linn.) K. Schum.
Common, only in Hare Island. (20-1-57 ; 17, 18-5-61).

COMPOSITAE

Vernonia cinerea Less.
Common, in both the islands, in flower. (20-1-57 ; 17, 18-5-61)

Blumea obliqua (Linn.) Druce
Common, in both the islands. (20-1-57 ; 17, 18-5-61).

Emilia sonchifolia DC.

Common, only in Hare Island, in flower. (8-2-45).

Launaea sarmentosa (Willd.) Alston

Common, in both the islands, in flower. (20-1-57, 17, 18-5-61).

Eclipta prostrata Linn.

Common, only in Hare Island, in flower. (20-1-57; 18-5-61).

GOODENIACEAE

Scaevola plumieri Vahl

Common, in both the islands, in flower and fruit. (8-2-45 ; 20-1-57 ; 17, 18-5-61).

SALVADORACEAE

Salvadora persica Linn.

Common, in both the islands, in flower. (17, 18-5-61).

GENTIANACEAE

Enicostemma hyssopifolium (Willd.) Verdoorn

Common, in both the islands, in flower and fruit. (20-1-57 ; 17, 18-5-61).

CONVOLVULACEAE

Ipomoea pes-caprae (Linn.) Sweet

Common, in both the islands. (20-1-57, 17, 18-5-61).

SOLANACEAE

Solanum surattense Burm.

Common, only in Hare Island, in flower and fruit. (20-1-57 ; 18-5-61).

Physalis minima Linn.

Common, only in Hare Island, in flower. (12-2-47 ; 18-5-61).

SCROPHULARIACEAE

Striga asiatica (Linn.) O. Kuntze

Common, in both the islands, in flower and fruit. (20-1-57 ; 17, 18-5-61).

Striga euphrasioides Benth.

Common, in both the islands, in flower and fruit. (20-1-57 ; 17, 18-5-61).

ACANTHACEAE

Justicia tranquebariensis Linn.f.

Common, only in Hare Island, in flower and fruit. (18-5-61).

VERBENACEAE

Clerodendrum inerme Gaertn.

Common, in both the islands, in flower and fruit. (20-1-57 ; 17, 18-5-61).

Avicennia officinalis Linn.

Common, only in Hare Island. (20-1-57 ; 18-5-61).

LABIATAE

Geniosporum prostratum Benth.

Common, in both the islands, in flower and fruit. (17, 18-5-61).

Leucas aspera Spr.

Common, only in Hare Island, in flower. (18-5-61).

NYCTAGINACEAE

Boerhavia diffusa Linn.

Common, only in Hare Island, in flower. (20-1-57 ; 18-5-61).

AMARANTHACEAE

Celosia polygonoides Retz.

Common, only in Hare Island, in flower. (20-1-57 ; 18-5-61).

Amaranthus polygamus Linn.

Common, only in Hare Island, in flower. (20-1-57 ; 18-5-61).

Pupalia lappacea Moq.

Common, only in Hare Island, in flower and fruit. (20-1-57 ; 18-5-61).

Achyranthes aspera Linn.

Common, only in Hare Island, in flower. (18-5-61).

Aerva lanata Juss.

Common, in both the islands, in flower. (17, 18-5-61).

A. javanica (Burm.f.) Spr.

Common, in both the islands, in flower. (20-1-57 ; 17, 18-5-61).

Chenopodiaceae

Artiplex stocksii Boiss.

Common, in both the islands, in flower and fruit. (20-1-57 ; 17, 18-5-61).

Arthrocnemum indicum Moq.

Common, in both the islands. (17, 18-5-61).

Salicornia brachiata Roxb.

Common, in both the islands. (17, 18-5-61).

Suaeda monoica Forsk.

Common, in both the islands, in flower. (17, 18-5-61).

S. fruticosa Forsk.

Common, in both the islands, in flower. (17, 18-5-61).

S. nudiflora Moq.

Common, in both the islands, in flower. (20-1-57).

Euphorbiaceae

Phyllanthus maderaspatensis Linn.

Common, in both the islands, in flower and fruit. (20-1-57 ; 17, 18-5-61).

Euphorbia hirta Linn.

Common, only in Hare Island, in flower. (18-5-61).

E. thymifolia Linn.

Common, only in Hare Island, in flower. (20-1-57 ; 18-5-61).

Jatropha glandulifera Roxb.

Common, only in Hare Island, in flower. (20-1-57 ; 18-5-61).

Hydrocharitaceae

Halophila ovata Gaud.

Common, in both the islands. (17, 18-5-61).

Liliaceae

Aloë barbadensis Mill.
Common, in both the islands. (17, 18-5-61).

Gloriosa superba Linn.
Few, only in Hare Island. (18-5-61).

Commelinaceae

Cyanotis axillaris Roem. & Schult.
Common, only in Hare Island. (20-1-57 ; 18-5-61).

Potomogetonaceae

Ruppia maritima Linn.
Common, in both the islands. (17, 18-5-61).

Cymodocea serrulata Aschers. & Magn.
Common, in both the islands. (17, 18-5-61).

Cyperaceae

Pycreus unioloides Dom. var. **angulata** Dom.
Common, only in Hare Island. (20-1-57 ; 18-5-61).

P. odoratus Urb.
Common, only in Hare Island. (18-5-61).

Cyperus triceps (Rottb.) Endl.
Common, only in Hare Island, in flower. (20-1-57 ; 18-5-61).

C. castaneus Willd.
Common, only in Hare Island, in flower. (20-1-57).

C. arenarius Retz.
Common, in both the islands, in flower. (20-1-57 ; 17, 18-5-61).

C. pachyrrhizus Nees
Common, in both the islands, in flower. (20-1-57 ; 17, 18-5-61).

Fimbristylis diphylla Vahl
Common, only in Hare Island, in flower. (8-2-45 ; 20-1-57 ; 18-5-61).

F. dichotoma Vahl
Common, only in Hare Island, in flower. (20-1-57).

Fimbristylis annua Roem. & Schult.
Common, only in Hare Island, in flower. (20-1-57).

F. spathacea Roth
Common, only in Hare Island, in flower. (20-1-57).

F. monostachya Hassk.
Common, only in Hare Island. (20-1-57).

Bulbostylis barbata Kunth
Common, in both the islands, in flower. (20-1-57).

B. capillaris Kunth var. **trifida** Clarke
Common, only in Hare Island, in flower. (20-1-57).

GRAMINEAE

Spinifex littoreus (Burm.f.) Merr.
Common, in both the islands. (20-1-57 ; 17, 18-5-61).

Dichanthium annulatum (Forsk.) Stapf
Common, in both the islands, in flower. (17, 18-5-61).

Eremopogon foveolatus (Del.) Stapf
Common, only in Hare Island, in flower. (20-1-57).

Cymbopogon caesius (Nees) Stapf
Common, in both the islands, in flower. (8-2-45 ; 20-1-57 ; 17, 18-5-61).

Brachiaria ramosa (Linn.) Stapf
Common, only in Hare Island, in flower. (18-5-61).

B. reptans (Linn.) Gardn. et C.E. Hubb.
Common, only in Hare Island, in flower. (18-5-61).

Cenchrus ciliaris Linn.
Common, in both the islands, in flower. (8-2-45 ; 20-1-57 ; 17, 18-5-61).

C. ciliaris var. **echioides** Hook. f.
Common, in both the islands, in flower. (8-2-45 ; 20-1-57 ; 17, 18-5-61).

C. setigerus Vahl
Common, only in Hare Island, in flower. (8-2-45 ; 20-1-57 ; 17, 18-5-61).

Aristida depressa Retz.
Common, in both the islands, in flower. (20-1-57 ; 17, 18-5-61).

Sporobolus elongatus R.Br.
Common, in both the islands, in flower. (20-1-57 ; 17, 18-5-61).

S. tremulus Kunth
Common, only in Hare Island, in flower. (20-1-57).

S. virginicus Kunth
Common, only in Hare Island, in flower. (20-1-57).

S. marginatus Hochst. ex A. Rich.
Common, in both the islands, in flower. (20-1-57 ; 17, 18-5-61).

Eragrostis tenella (Linn.) P. Beauv. ex Roem. et Schult.
Common, only in Hare Island, in flower. (20-1-57 ; 18-5-61).

Halopyrum mucronatum Stapf
Common, in both the islands, in flower. (20-1-57 ; 17, 18-5-61).

Cynodon dactylon Pers.
Common, only in Hare Island, in flower. (20-1-57 ; 17, 18-5-61).

Chloris inflata Link.
Few in Church Island and common in Hare Island, in flower. (8-2-45 ; 20-1-57 ; 17, 18-5-61).

Coelachyrum lagopoides (Burm.f.) Senaratna
Common, in both the islands, in flower. (20-1-57 ; 17, 18-5-61).

Dactyloctenium aegyptium (Desf.) Beauv.
Common, only in Hare Island, in flower. (20-1-57 ; 18-5-61).

A Preliminary Account of the Water Bugs of the Family Corixidae in Ceylon

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(*With* 43 *figures on four plates*)

Introduction

The Corixidae are the most abundant of the aquatic Hemiptera in Ceylon, yet relatively few records are available of their occurrence and hardly any data on their biology. A number of species have been described or recorded from Ceylon but later revisions have shown them to be synonyms or they have not been sufficiently authenticated. It is therefore difficult to give a complete list of the species known to occur in Ceylon.

The present paper is intended as a critical review of the literature on the Ceylonese Corixidae and a reliable guide to specific diagnosis based on recent work. Short notes of diagnostic value are given for each species with illustrations. All the species authenticated so far are included except those described by Wroblewski (1964). Short notes on the biology and distribution of each species are given. The material on which the present study is based was collected by the author over a number of years from all parts of Ceylon. It is likely that the species list is therefore fairly complete. The general biology of Corixidae is mentioned briefly.

Review of Literature

Motschoulsky (1863) described *Corixa albifrons* from Ceylon. Horvath (1904) added another species *Micronecta haliploides.* Kirkaldy (1905) described *Micronecta thelxinoe* and *M. memonides.* Distant (1906) mentions two species *Micronecta striata* (Fieb.) and *M. haliploides.* He included *Micronecta albifrons* as a synonym of *M. striata.* Distant (1910) added records of two new species *Micronecta lucina* and *M. minthe* and listed three others, *Corixa substriata* Uhler, *Micronecta thelxinoe,* and *M. memonides.* Lundblad (1933) listed eight species from previous re-

cords. His list included, besides those mentioned by earlier workers, *Micronecta quadristrigata* Bredd. for the record of *M. minthe.* He also included *Micronecta ovivora* West. in the Ceylonese list. Hutchinson (1940) placed the specific diagnosis of Indian and Ceylonese species on a sound footing. He accepted only two of Lundblad's (1933) records, namely *Micronecta haliploides* and *M. quadristrigata.* Two other species found in Ceylon, *Micronecta albifrons* and *M. scutellaris,* were described. Fernando (1959) recorded *Micronecta quadristrigata, M. albifrons,* and *M. haliploides* from temporary habitats. Chen (1960) described two new species from Ceylon, namely *Micronecta tarsalis* and *M. fascioclavus,* and mentioned the occurrence of *M. thyesta.* Wroblewski (1960) added a new species, namely *Micronecta flavens.* Fernando (1961*b*) recorded *Micronecta quadristrigata* and *M. albifrons* at light. Mendis & Fernando (1962) made a list of species, adding *Agraptocorixa hyalinipennis* (F.). Fernando (1963*a*) added five new records, namely *Micronecta ludibunda* Bredd., *M. prashadana* Hutch., *M. siva* Kirk., *M. punctinotum* Chen, and *Tropocorixa pruthiana* Hutch. All these species were recorded by him (Fernando 1963*b*) at light, but *Micronecta ludibunda* was referred to as *M. albifrons.* Wroblewski (1963) described the male of *Micronecta punctinotum* from material sent by the present author, in which he found also *Micronecta* sp. closely similar to *M. issa* Dist. Wroblewski (1964) has a description of a new species from Ceylon, *Micronecta fernandoi* and a redescription of *M. memonides.*

The synonymy of the various species of Corixidae will not be discussed as this has been done by Hutchinson (1940) and Chen (1960). There are however a number of species which are doubtful. They will be discussed later. Detailed descriptions of Ceylonese species are given by Hutchinson (1940), Chen (1960), and Wroblewski (1960) and also by Lundblad (1929, 1933).

A summary of the present position as regards the Corixidae recorded from Ceylon is given at the end of the taxonomic section.

Taxonomy

The genera of Ceylonese Corixidae can be easily separated using the following key :

1. Scutellum visible (Fig. 1)..MICRONECTINAE
Micronecta
Scutellum not visible (Fig. 2)..CORIXINAE
....2

2. (*a*) Hemelytra unicolorous : No transverse stripes on pronotum............
Agraptocorixa

(*b*) Hemelytra with vermiculate markings (Fig. 10) : Pronotum with transverse stripes (Fig. 2)..*Tropocorixa*

The accurate specific diagnosis of the Corixidae leans heavily on the structure of the male genitalia. It is often necessary to dissect out the genital claspers (parameres) and study them in some detail. In the Micronectinae other important characters are the shape of the free lobes of the eighth abdominal tergite and the submedian lobe of the seventh abdominal sternite, the chaetotaxy of the foreleg, and the shape of the palar claw of the male. Females are sometimes difficult to diagnose to species. In the Corixinae, the arrangement of the palar pegs in the fore-tarsus of the male is usually characteristic. Colour patterns of the pronotum and hemelytra are useful and even distinctive in some species (Figs. 10-19). In the group *Micronecta ludibunda*, *M. siva*, and *M. fascioclavus* the hemelytra have solid lines. In *Micronecta punctata* and *M. punctinotum* there are dark spots. The hemelytra of *Agraptocorixa hyalinipennis* are unicolorous, whilst that of *Tropocorixa pruthiana* have vermiculate markings. The markings on the pronotum are distinctive in some species. In *Micronecta siva* and *M. fascioclavus* there are solid dark markings (Figs. 5, 6). In *Tropocorixa pruthiana* (Fig. 2) the dark markings are closely crowded. In *Micronecta punctinotum* there are punctations (Fig. 3). With practice many of the species can be recognized in the field. The Corixinae are much larger than the Micronectinae, the former measuring 5-10 mm. in length whilst the latter rarely exceed 3 mm. Amongst the Micronectinae the largest species is *Micronecta scutellaris*, whilst the smallest are the group *M. tarsalis* and the two others which have been described by Wroblewski (1964).

Agraptocorixa hyalinipennis (F.)

(Fig. 20)

This is the largest species found in Ceylon. It measures 6-7 mm. in length and is over 3 mm. in maximum breadth. The pronotum and hemelytra are unicolorous except for a small oval dark spot on the latter; this feature separates it from the only other large corixid, *Tropocorixa pruthiana*, which has dark transverse markings on the pronotum and vermiculate markings on the hemelytra. The parameres are shown in Fig. 20.

It has been collected in stagnant forest ponds in Ratmale (near Maho); Wilpattu National Park; Palatupana, Yala; Kirinda; and Ambalantota. In Ceylon it appears to be restricted to the drier parts and occurs in forest ponds with an abundance of vegetation. The author collected the species from Malaya and Burma from highly polluted ponds without much vegetation. Jaczewski (1962) gives the distribution as India, Burma, Viet Nam, Indonesia, and Japan.

Tropocorixa pruthiana Hutch.

(Figs. 10, 21)

This species measures 5-5.5 mm. in length and about 2.5 mm. in maximum breadth. The pronotum has seven transverse yellow lines the second, third, and fourth of which are broken. The hemelytra show vermiculate markings (Fig. 10). It is characterised by these features and the structure of the parameres (Fig. 21).

It has been collected from Ambalantota, Kirinda and Amupitiya (near Belihul-oya), and Kande-ela—in the first two localities in forest ponds together with *Agraptocorixa hyalinipennis* and in Amupitiya from a stream in a terraced paddy field. Hutchinson (1940) placed it in a group of species occurring at elevations of 700-1000 ft. in India. It has so far been recorded only from India and Ceylon, where it occurs over a wide range of elevations.

Corixa substriata recorded from Ceylon by Distant (1910) probably refers to this species.

Micronecta thyesta Dist.

(Figs. 11, 22, 33)

This is a medium-sized elongate species with light-coloured hemelytra which gives it a distinctive appearance amongst the *Micronecta* species found in Ceylon. The hemelytra are markedly pubescent with long close-set hairs. It is the only species without a strigil. The parameres (Fig. 22) and the free lobe of the eighth abdominal tergite (Fig. 33) are characteristic.

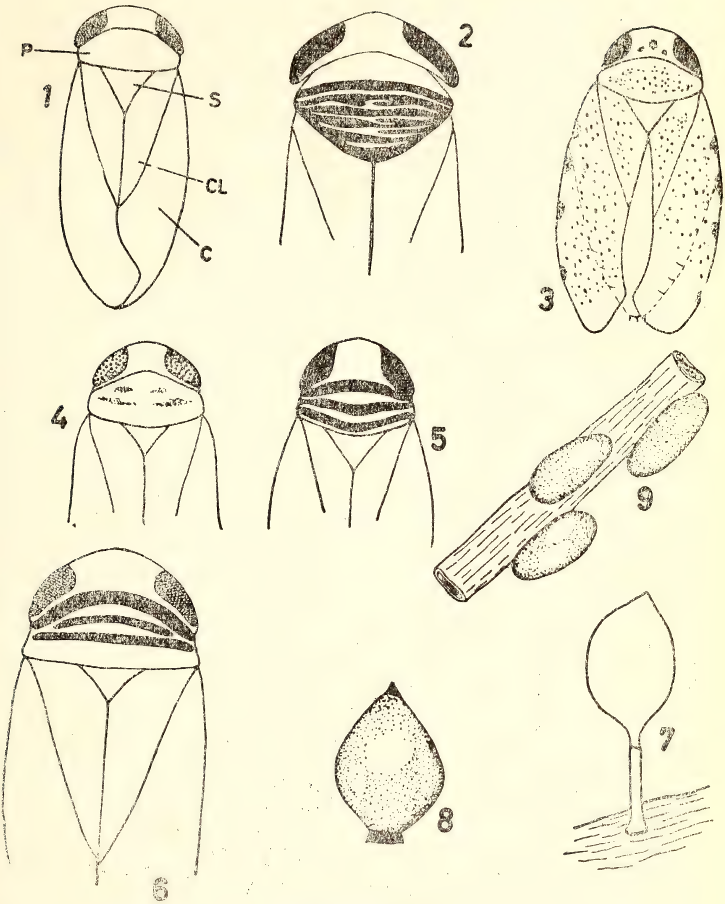
It has been recorded from Ceylon by Chen (1960) and by Fernando (1963*a*). In the material examined it was a common species in ponds in the southern part of Ceylon.

It has been recorded from India, Malaya, Taiwan, Ceylon, and Thailand.

Micronecta scutellaris Stal.

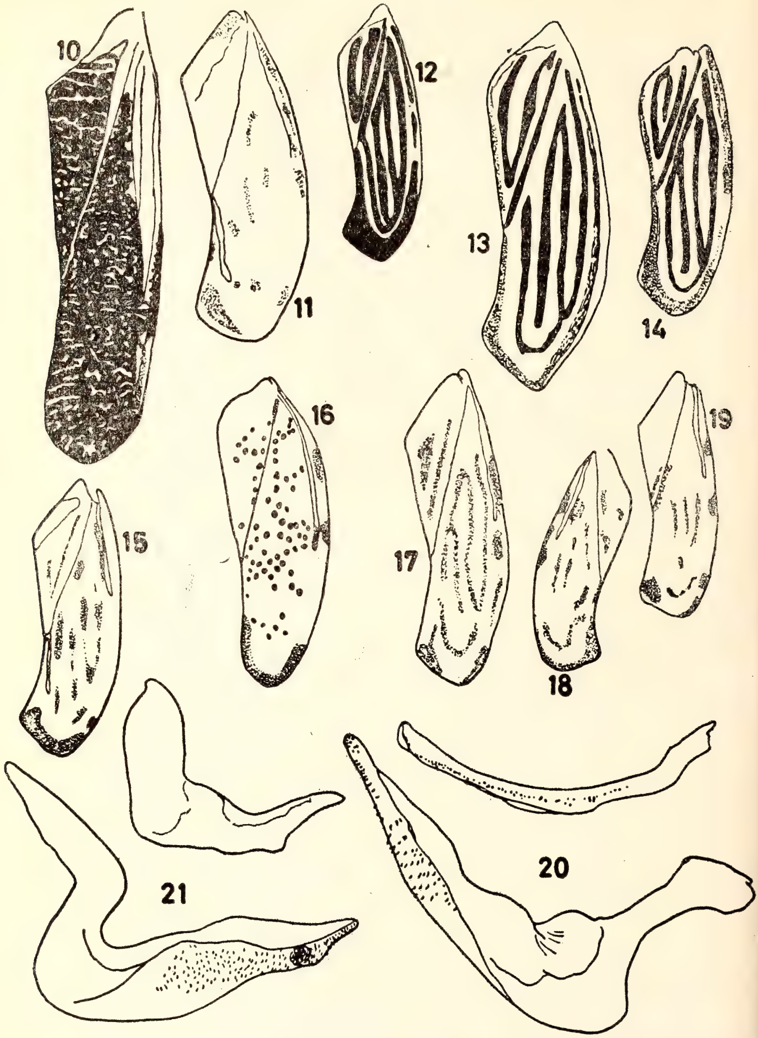
(Figs. 15, 27, 39)

Of the species of *Micronecta* this is the largest, measuring over 3 mm. in length. The hemelytra show a considerable variation in markings but there is usually a series of broken lines in both clavus and corium (Fig. 15). The hemelytra are pubescent. The left paramere is rugose in its terminal portion, the rugosities extending about halfway along its length and running across the shaft (Fig. 27). The free lobe of the eighth abdominal tergite is shown in Fig. 39.



Corixidae of Ceylon

Fig. 1. *Micronecta*: P. pronotal shield, S. scutellum, CL. clavus, C. corium; 2. *Tropocorixa* showing pronotal markings; 3. *Micronecta punctinotum*; 4-6. *M. ludibunda*, *M. fasicoclavus*, and *M. siva*, showing pronotal markings; 7. Egg of *Agraptocorix hyalinipennis*; 8. Egg of *Tropocorixa pruthiana*? (obtained from gravid female); 9. Eggs of *Micronecta*



Corixidae of Ceylon

Figs. 10-19. Hemelytra: 10. *Tropocorixa*; 11. *Micronecta thyesta*; 12. *M. ludibunda*; 13. *M. siva*; 14. *M. fascioclavus*; 15. *M. scutellaris*; 16. *M. punctata*; 17. *M. quadristrigata*; 18. *M. prashadana*; 19. *M. flavens*; 20-21, Parameres (left longer than right); 20. *Agraptocorixa hyalinipennis*; 21. *Tropocarixa pruthiana*

Micronecta scutellaris is perhaps the most widely distributed species of *Micronecta* in south-east Asia. It has been recorded from both the Oriental and the Ethiopian regions. It occurs in Africa, India, Burma, China, Ceylon, and Malaya.

In Ceylon it occurs in a wide variety of habitats. It has been collected in ponds, irrigation reservoirs, and brackish water. It has been recorded at light in Malaya (Fernando 1961*a*).

Micronecta ludibunda Bredd.

(Figs. 4, 12, 23, 35)

Superficially this species resembles *Micronecta siva* and *M. fascioclavus*. It is however distinctly smaller than *Micronecta siva* and lacks solid transverse lines in the pronotum (Fig. 4) which are found in both *M. siva* and *M. fascioclavus*. The parameres resemble those of *Micronecta fascioclavus* but are distinctive (Fig. 23). The free lobe of the eighth abdominal tergite is shown in Fig. 35.

The species described as *Micronecta albifrons* from Ceylon might well refer to this species, although it is more likely to be *M. fascioclavus*. Unfortunately, the type of *Micronecta albifrons* is no longer available (Wroblewski 1962*a*). Ceylonese material has been referred to this species in the past by Hutchinson (1940) and Fernando (1959, 1963*b*). The present material agrees closely with *Micronecta ludibunda* and is hence placed in this species, but in it were some specimens which had an added prominence near the base of the shaft of the right paramere not found in *Micronecta ludibunda* from Malaya and Indonesia.

The position of *Micronecta albifrons* and *M. ludibunda* is further complicated by Kirkaldy's (1905) species, *Micronecta thelxinoe* from Ceylon, and the forms described as *M. striatella* and *M. inconspicua* by Lundblad (1933) from Indonesia, which are probably all *M. ludibunda*. We have here, perhaps, a species complex and the status of the various forms needs a critical reassessment very badly.

Micronecta ludibunda has been recorded from Malaya, India, and Ceylon. According to Hutchinson's (1940) definition both Ceylonese and Malayan material belongs to *Micronecta albifrons*. It is therefore difficult to give exact limits for this species.

Micronecta siva Kirk.

(Figs. 6, 13, 24, 36)

This species is second in size to *Micronecta scutellaris*. Its coloration is distinctive. The corium has four prominent longitudinal stripes (Fig. 13) and the pronotum three thick transverse dark lines (Fig. 6). The

parameres (Fig. 24) differ markedly from those of *Micronecta ludibunda* and *M. fascioclavus*. The free lobe of the eighth abdominal tergite (Fig. 36) is somewhat similar to that of *Micronecta ludibunda*, but the posterior margin has an elevation.

Hutchinson (1940) states that all the specimens he examined had been collected at light. This species has been collected at light in Ceylon (Fernando 1963*a*). Distant (1906) states that his material came from a tank (irrigation reservoir). Hutchinson (loc. cit.) states that they probably live in the shallow water of large rivers. In Ceylon it has been collected from ponds bordering a river. It is likely that its normal habitats are ponds, which is true for the majority of Ceylonese species.

Micronecta siva has been recorded from India and Ceylon. Lundblad (1933) also records it from China under the name *Micronecta striata*. Earlier records of this species should be accepted with caution because of the lack of suitable criteria of separation between it and a number of closely related species at that time.

Micronecta fascioclavus Chen

(Figs. 5, 14, 25, 37)

It can be easily recognised by the three longitudinal stripes on the clavus (Fig. 14). This separates it from *Micronecta siva* and *M. ludibunda*. In size it is similar to the latter species. The parameres (Fig. 25) although resembling those of *Micronecta ludibunda* are distinctive and so is the free lobe of the eighth abdominal tergite (Fig. 37).

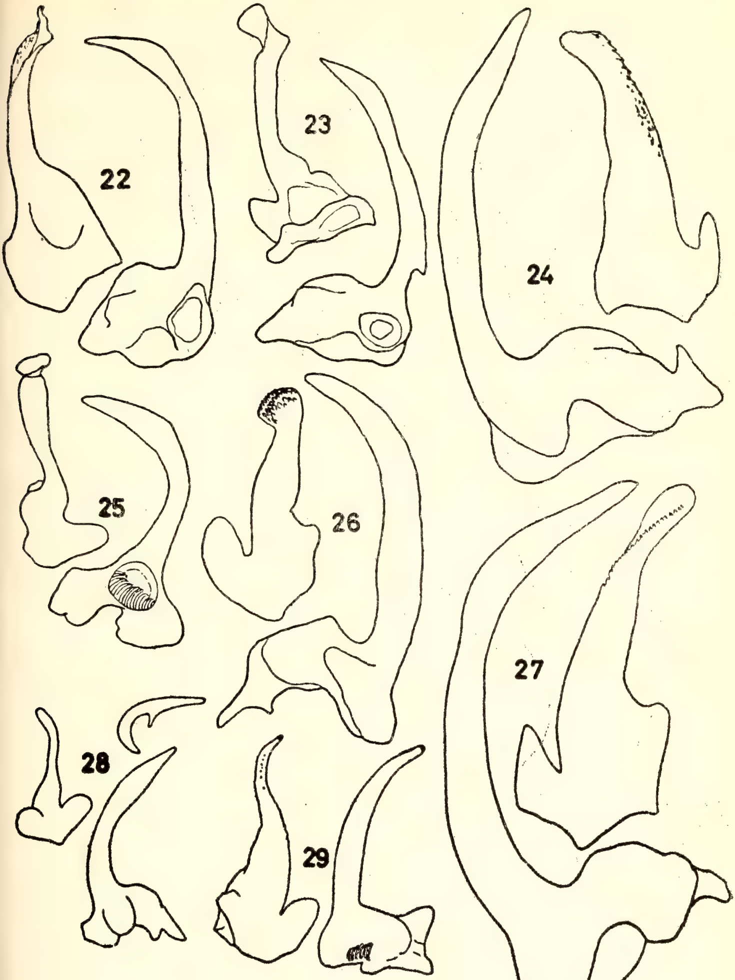
Micronecta fascioclavus was described from material collected in Colombo by Chen (1960). A large number were taken at light by the present author and also collected from ponds. There is a possibility that this species is in fact *Micronecta albifrons*, the types of which came from Colombo. It appears endemic to Ceylon.

Micronecta tarsalis Chen

(Figs. 28, 43)

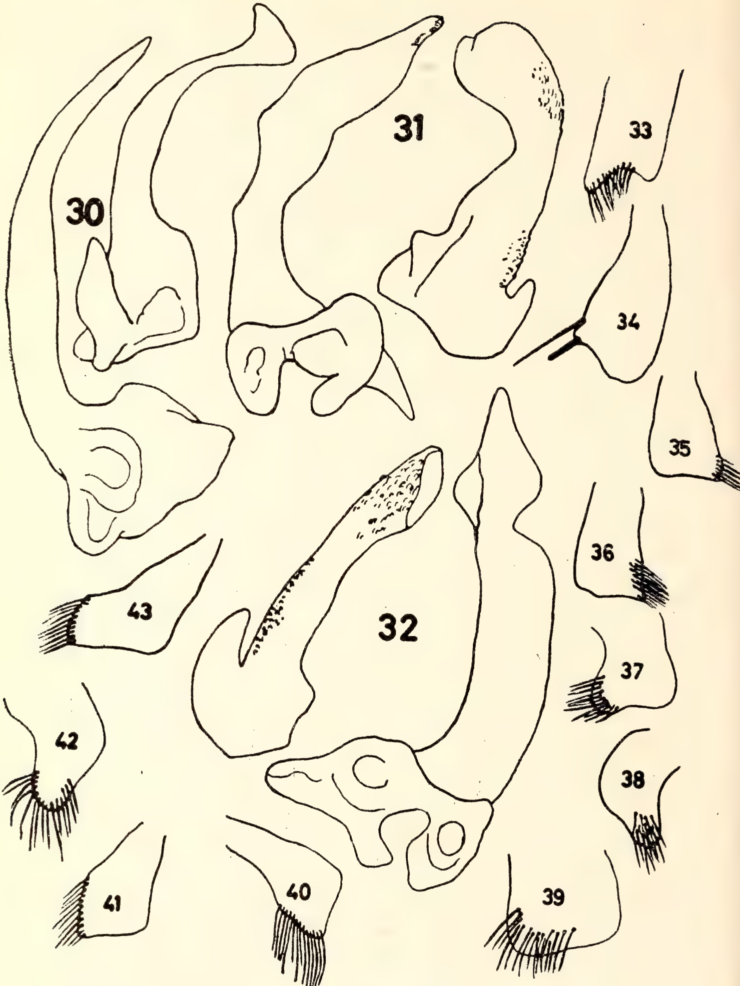
As its name indicates *Micronecta tarsalis* has a characteristic tarsal claw, with a tooth placed subapically in the foretarsus of the male. It is a small species with indistinct hemelytral markings and only brachypterous individuals are known. The parameres (Fig. 28) and the free lobe of the eighth abdominal tergite (Fig. 43) have been figured after Chen (1960).

I have not collected this species but found a number of specimens having a tarsal claw at the bottom of a waterfall at Diyaluma. They



Corixidae of Ceylon

Parameres (right longer than left) : Fig. 22. *Micronecta thyesta* ; 23. *M. ludibunda* ; 24. *M. siva* ; 25. *M. fascioclavus* ; 26. *M. punctata* ; 27. *M. scutellaris* ; 28. *M. tarsalis* and tarsal claw of same species ; 29. *M. punctinotum*



Corixidae of Ceylon

Figs. 30-32. Parameres (right longer than left) : Fig. 30. *Micronecta quadristrigata* ; 31. *M. flavens* ; 32. *M. prashadana* ; Figs. 33-43. Free lobe of eighth abdominal tergite : 33. *Micronecta thyesta* ; 34. *M. punctinotum* ; 35. *M. ludibunda* ; 36. *M. siva* ; 37. *M. fasciclavus* ; 38. *M. punctata* ; 39. *M. scutellaris* ; 40. *M. flavens* ; 41. *M. prashadana* ; 42. *M. quadristrigata* ; 43. *M. tarsalis*

proved to belong to the new species of *Micronecta* which has been described by Wroblewski (1964) as *M. fernandoi.*

The tarsal claw is probably an adaptation for mating.

Micronecta punctata (Fieb.)

(Figs. 16, 26, 38)

Until Chen (1960) established the synonomy of this species with *Micronecta haliploides*, the Ceylonese material was placed under the latter species. *Micronecta punctata* is the darkest species amongst the Ceylonese *Micronecta* in life. It is also broader than the other species relative to its length. The markings on the hemelytra are characteristic, consisting of large spots (Fig. 16). The parameres are shown in Fig. 26 and the free lobe of the eighth abdominal tergite in Fig. 38.

In Ceylon it is not a common species. It occurs in ponds and temporary habitats. It has also been recorded at light. It occurs in India, Ceylon, and Malaya.

Micronecta punctinotum Chen

(Figs. 3, 29, 34)

Superficially similar to *Micronecta punctata*, but much lighter in colour and smaller in size. The hemelytra and pronotum have punctations irregularly distributed (Fig. 3). The male was described from material identified for the present author by Wroblewski (1963) from whose paper the parameres (Fig. 29) and the free lobe of the eighth abdominal tergite (Fig. 34) have been figured.

This species has so far been recorded from India and Ceylon. It was taken at light by Fernando (1963*a*).

Micronecta quadristrigata Bredd.

(Figs. 17, 30, 42)

The commonest species in many countries of south-east Asia. It is of medium size with indistinct markings on the hemelytra (Fig. 17). The parameres (Fig. 30) are characteristic. The free lobe of the eighth abdominal tergite (Fig. 42) is angulate.

Micronecta quadristrigata has been recorded from Ceylon, India, Malaya, Viet Nam, Thailand, Philippines, Hong Kong, and Iran. It is common in paddy fields (Ardiwinata 1957, Fernando 1959). It is also the commonest species at light. It has been taken at light in India, Ceylon, Indonesia, Malaya, and more recently in Viet Nam (Wroblewski 1962*b*).

In Ceylon it occurs in paddy fields, ponds, irrigation reservoirs, and small pools both temporary and ephemeral, showing its great mobility.

Micronecta prashadana Hutch.

(Figs. 18, 32, 41)

This species has been recorded only from India and Ceylon. It is a rather pale, small species with indistinct longitudinal markings on the hemelytra (Fig. 18). The parameres are very characteristic (Fig. 32) and the free lobe is shown in Fig. 41.

It was collected in India together with *Micronecta scutellaris* and *M. quadristrigata* in a shallow pool in a marsh. In Ceylon it was taken at light with *Micronecta quadristrigata*, *M. ludibunda*, *M. siva*, and *M. scutellaris* at Polonarrawa. It is probably an inhabitant of ponds.

Micronecta flavens Wroblewski

(Figs. 19, 31, 40)

It is a small species with a few dark markings on the hemelytra (Fig. 19). Material belonging to this species was identified as *Micronecta haliploides* and this was used by Wroblewski (1960) to describe it. The parameres are very characteristic (Fig. 31) and the free lobe is shown in Fig. 40.

Numerous specimens were collected by Fernando (1959) from rock pools in a river bed. He identified them as *Micronecta haliploides*. Subsequent examination of the material has shown it to be *Micronecta flavens*.

The only recorded habitat for this species is a rock pool. It has also been collected at light.

List of Corixidae recorded from Ceylon

(*a*) Authenticated species :

Agraptocorixa hyalinipennis.
Tropocorixa pruthiana.
Micronecta ludibunda.
Micronecta siva.
Micronecta fascioclavus.
Micronecta quadristrigata.
Micronecta scutellaris.
Micronecta punctata.
Micronecta punctinotum.
Micronecta flavens.
Micronecta prashadana.
Micronecta tarsalis.
Micronecta thyesta.
Micronecta memonides.
Micronecta fernandoi.

(*b*) Species needing redescription or authentication :

Micronecta albifrons.
Micronecta thelxinoe.
Micronecta lucina.

(*c*) Synonyms :

Micronecta striata=M. siva.
Micronecta minthe=M. quadristrigata.
Micronecta haliploides=M. punctata.

(*d*) Species to be deleted from previous lists :

Sigara substriata.
Micronecta ovivora.

Biology

The corixids usually inhabit shallow water. They seem to prefer undisturbed water and seldom occur in streams and, if they do, are confined to the calm backwaters. In Ceylon they are found in a wide range of habitats, occurring in ponds of all sizes, the edges of tanks (irrigation reservoirs), rock pools in river beds, waterfalls, marshes, and paddy fields.

Hutchinson (1940) states that *Micronecta* is common in ponds without much vegetation. In Ceylon they are often found in ponds with abundant vegetation. They have also been observed amongst masses of *Spirogyra* or sometimes in ponds without much vegetation. Since they feed on the bottom ooze, they are often abundant where there is a rich supply of plant detritus. Because of their great mobility they are sometimes numerous in small pools just after heavy rains, but these pools can hardly be considered the normal habitat since they are in most cases ephemeral.

The habitats of three species are perhaps worth mentioning. *Micronecta flavens* has so far been recorded only in rock pools on a river bottom, and the two species described by Wroblewski (1964) from the bottom of a waterfall. Whether these habitats are specific is not known.

Of the two species of Corixinae, *Agraptocorixa hyalinipennis* lives in forest ponds with abundant vegetation and *Tropocorixa* has been collected in the same habitat and also from terraced paddy fields.

Our present knowledge of the habitats of the various species of Corixidae in Ceylon is too meagre for any conclusions as to whether there is any selection of habitats or succession of species with changes in the habitat. The instability of most of their habitats due to seasonal droughts has perhaps made mobility a distinct advantage.

The food of corixids consists mainly of bottom ooze (Griffiths 1945, Slack 1947, Sutton 1951). Westwood (quoted in Hutchinson 1940) states that *Micronecta ovivora* feeds on fish eggs and Hutchinson (loc. cit.) considers this probably true. Wroblewski (1963) who re-examined

Micronecta ovivora considers this unlikely in the absence of any special morphological features. Because of their herbivorous habits and the ability to use bottom detritus they often reach enormous numbers in suitable habitats.

The breeding habits of corixids have not been studied in any of the south-east Asian countries except for the work of Fernando & Leong (in press). The eggs are laid on a variety of objects, generally water plants, dried vegetation, and stones. The eggs of *Micronecta* spp. are common enough on vegetation. They are unstalked (Fig. 9). Eggs of *Agraptocorixa hyalinipennis* have been collected in Ceylon from a forest pond in Palatupana, Yala, on 26-4-1962. They are stalked (Fig. 7). No eggs of *Tropocorixa* have been collected in the field but I obtained some from a gravid female. The eggs have a short basal disc for attachment (Fig. 8). The eggs of *Micronecta* have been described by a number of workers from many parts of the world. Fernando & Leong (1963*c*) have described the eggs of *Micronecta quadristrigata*. The eggs of *Tropocorixa* have been studied by Hungerford (1948), and those of *Agraptocorixa* by Walton (1963) and Fernando & Leong (loc. cit.). In *Micronecta* egg-laying is usually after the rains. The eggs of *Agraptocorixa hyalinipennis* were collected at the end of a dry period.

Most Corixidae are good fliers and are often recorded at light or in isolated habitats. The literature on their occurrence at light is given by Fernando (1961*b*). In Ceylon the following species have been recorded at light: *Micronecta quadristrigata*, *M. scutellaris*, *M. ludibunda*, *M. thyesta*, *M. flavens*, *M. punctinotum*, *M. fascioclavus*, and *M. punctata*. Most of these species have also been found in temporary and artificial habitats.

The most important predators of Corixidae are probably the large aquatic insects. Fish no doubt feed on them. They are sometimes parasitized by Hydracarina, and Protozoa and Nematoda have been recorded from them.

Summary

A preliminary account of the Corixidae of Ceylon is given. This includes a critical survey of the literature and short descriptions of each species, except two recently described by Wroblewsky (1964).

The status of some of the species is briefly discussed and an attempt made to sort out the synonomy.

The biology of the Ceylonese species is briefly mentioned and some remarks made on the general biology of the Corixidae.

Acknowledgements

Some of the material used in the present study was collected during a freshwater fisheries survey sponsored by the Fisheries Department,

Ceylon, and supported by the F.A.O. I wish to thank Dr. A. Wroblewski of the Institut Zoologiczny, Poznan, Poland, for his suggestions and for checking up some of the identifications.

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Notes on the Life History of *Nacaduba pactolus continentalis* Früh. (Lepidoptera : Lycaenidae) from Poona District, Western Ghats

BY

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(With two plates and four text-figures)

I am now able to contribute some observations on the early stages of this interesting jungle insect. As previously reported in this *Journal* (Vol. **56** : 647-52) it occurs in a small area of what I believe would be called climax jungle in the region of Khandala (Poona District, alt. *c.* 650 metres). This is its most northerly locality so far reported on the Western Ghats, and the only one I have managed to find. The food-plant occurs in isolated patches in the Khandala jungles.

The first undoubted egg was taken just after it had been laid on a young shoot of *Entada pursaetha* DC.[1] in the jungle on 23 October 1960. I managed to catch the butterfly immediately after I had seen it lay. On the same day I found four similar eggs on another *Entada* on which there were also about eight green Lycaenid larvae. On examining the spray on which the identified egg had been laid I found two egg-larvae.

Already in July 1960 I had tried to rear some similar larvae which died in their first or second moult.

The eggs found on 23 October 1960 did not hatch, but two of the green larvae found on the same day pupated on November 3 and 5. A small but otherwise perfect male *Nacaduba pactolus* emerged on 12 November 1960, and a deformed female on 13 November.

More eggs, and larvae at all stages, were found towards the end of the monsoon in September 1961. In spite of all care, and

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[1] Santapau (1960) has established that this is the correct name of the *Entada* found at Khandala and along the Western Ghats generally. It had been known before this as *Entada scandens*.

invariably fresh, young foodstuff, only four larvae from twelve eggs attained even two-thirds of their growth.

However, on 1 October 1961 seven larvae mostly nearing full growth were found, two in association with *Camponotus* ants. Of these larvae one died in moult, and a presumably healthy specimen was put in preservative. The remaining larvae pupated, and produced five male *Nacaduba pactolus continentalis* on 10, 11, 12, and 16 October 1961, all perfect specimens.

I was away from India in 1962. In July 1963, after keeping a look-out from May, the butterfly was seen again and eggs were found. These did not hatch, but from early September until early November I had a number of successful rearings, four right through from the egg, and eight from first or second instar larvae. Details of the improved methods used will be given below. An equal number of males and females was obtained.

Description and Habits

Butterfly. The description in Wynter-Blyth (1957), based on Evans (1932), is reproduced for convenience: 'The 4-Lineblues UNF no pale basal lines; only a pair end cell, a discal pair and marginal markings. Tailed. UNF inner marginal line broad, diffused and continuous; all markings broad and yellowish. Wings broad and rounded, especially in the female. Male: above dark purple-brown, paler in a side light, with fine dark border line. Female: bases purple-blue, paling outwardly. Broad dark borders F; veins clearly marked.' Expanse: 34-38 mm. (Evans 1932).

Dr. T. Norman kindly sent me the following notes on the distribution and habits of the butterfly in Assam. He says: 'Over here it is a common and widely distributed insect in all types of forest, at least up to about 2000 ft. . . . Most of Cantlie's specimens came from medium altitudes, 3000 ft. to 4000 ft. on the southern side of the Khasi Hills. In Assam one finds it in ones and twos at damp sand beside streams or on forest paths (males only); or single specimens of both sexes flying in the undergrowth. It does not fly outside the forest, nor does it ever join the big "congregations" of *Nacaduba* spp. at damp patches. . . . When I say it is suite common, I mean that on a day's outing at the right season, and providing one was concentrating on this species only, one would be able to take perhaps 50 specimens.'

Judging by the number of examples seen or caught, and the many eggs and larvae noticed, the species appeared to be common in the

Khandala jungle during the monsoon of 1963. It does not seem to mind rain, and flies during drizzle. When a heavy shower comes it takes shelter. I caught one in such circumstances clinging to a bare stalk, body up, wings down. As soon as there is some lightening of the sky and slight warmth from the sun behind the driven clouds it is again on the wing. I saw the males perching high on the *Entada*, about thirty feet up, and coming down to lower leaves in a clearing when light rain had passed. Unfortunately I failed to capture one.

I found that the butterfly is quite eager for the nectar of flowers. This is not surprising when one considers it must need to have its energies renewed after long periods of cold and damp. I caught two females and one male at flowers of a *Justicia*, probably *diffusa*, (Acanthaceae), which at the latter end of the rains grows all over the open patches outside the thick jungle.

Egg. I found the egg on the young leaves, shoots, and tendrils of *Entada pursaetha*. Both young plants and the new growths of ancient lianas seem equally suitable. The eggs were found on the undersurfaces of young red leaflets or perhaps more often in their axils. Leaves which have turned green will do, but they must be very tender. A favourite place is the terminal bud of a new shoot which will open out into ideal food three days later at the same time as the larva hatches.

The general colour of a *pactolus* egg is honey-yellow to the naked eye, but for some reason it seems whiter under the microscope. The white cell walls no doubt contribute to this effect.

The height is about one-third of the breadth. In shape it is a very flat egg, reminiscent of a Government servant's *pagri*.

Looked at from above there seem to be about four rows of cells decreasing in size between the edge of the top surface and the central space around the micropyle. The cells have irregular white walls enclosing rough hexagons in some cases, but more often squarish shapes, the floor of these cells is minutely pitted irregularly all over. The top surface of the egg is depressed, and the central space containing the micropyle is dark grey, minutely tubercular, and rather bigger than the large white-walled cells on the outside edge of the egg. A lighter grey extends outside the dark grey central space, and gives the effect of a roughly drawn four-pointed star.

Viewed from the side the flatness of the egg and the irregularity of the cells is apparent. Both on the top surface and on the sides the cells consist of lumps joined together by wide walls. The larger lumps, at least, have a low depression in their crown.

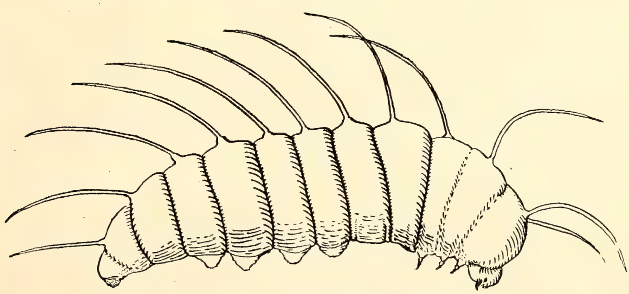
It should be mentioned that, in contrast with *pactolus*, the egg of

Nacaduba beroe gythion Früh. is rounder in contour. The cells consist of a larger number of small rounded knobs, more than the lumps in *pactolus*; the knobs are connected by narrow walls, giving a prickly contour and in general reminding one of a golf ball. Bell (1918)[1] aptly describes the rows of knobs on a *beroe* egg as radiating 'outwards in slowly diverging curves like a catherine wheel firework'. This is quite unlike the slabby appearance of *pactolus*.

In the jungle in question *N. beroe* as well as *N. pactolus* lay on *Entada*, so it is useful to be able to distinguish the two eggs with fair certainty in the field. In *pactolus* there is always a grey centre and it may look yellow; *beroe* has no darkened centre and always looks enamel-white, although the ground colour is actually yellow.

The eggs of *N. pactolus* do not seem to change noticeably in colour before the little larva comes out. This may indicate either that the eggshell is thick, or that the lumpy cell-walls hide any change of colour from casual observation. On the two occasions when I did notice a change to dark blue or violet the larvae did not emerge.

Larva. The young larvae vary in colour from pale yellow to honey-yellow. In the first instar they have the usual row of long dorsal bristles, and shorter lateral hairs. The dorsal bristles, particularly, must act as a spring when the little larva falls, and protect it generally. They were brown in a day-old larva. The lateral hairs were lighter in colour, and so far as I could see alternately long and short. None were as long as the dorsal bristles. See Text-fig. 1,



Text-fig. 1. Egg-larva (diagrammatic)

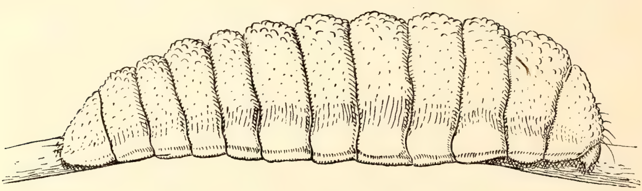
where for lack of sufficient information the lateral hairs are not shown.

[1] For an unrivalled description of *Nacaduba beroe* at all stages, see Bell (1918, pp. 661-4) under the name *Nacaduba plumbeomicans* W.-M. & De N.

At the first moult the hairs are shed with the skin, and the colour becomes apple-green, sometimes with a red-brown line above the legs fading out at about somite 3. The fore-end is now massive and the general shape rather carrot-like, especially in the resting position when the head is drawn into the thorax. The small head is pale yellow, with eyes and mouth-parts dark brown. It is usually more or less hidden by the first thoracic segment, but darts forward quite often when the creature is eating. There may be a light-brown suffusion on the first few segments, and usually a dark-green rather vague dorsal line, most noticeable from the third thoracic to the third abdominal segment. Palpitation of the aorta can be seen along this line. There is also some darker green dorsally on segments 7 and 8 of the abdomen. It is on these segments that the median-dorsal secretory organ and the dorso-lateral eversible organs are situated.

When once the larva had shed its long-haired vestiture and become green I observed no colour changes throughout the remaining stages. There may well be a pink form as in *N. beroe* but I have not come across it.

The whole skin surface of the larva is minutely pitted, most noticeably in the full-grown larva (Text-fig. 2). The ample folds and creases of the forepart of the thorax then make it quite impressively elephantine under the lens. At maximum growth it is about 12 mm. long.



Text-fig. 2. Full-grown larva (diagrammatic)

Larval habits. Eclosion took place in the usual three days after the egg was laid. The little larva did not consume the eggshell, at least in captivity. It gets out more or less from the side of the egg. A larva, shortly after emerging, was seen to go to the underside of a small green leaflet, where it began to eat irregular holes, leaving the upper epidermis as a transparent film. The young larvae are fairly active and may move from one leaflet to another, eating here and there, and this in spite of the food being quite fresh. They keep to the undersides of the leaflets. They do not get between the young

red leaflets while they are still pressed together before expansion. In contrast, young *N. beroe* larvae make a practice of getting into such places and feeding there.

As with many Lycaenid larvae, it is difficult to tell whether *pactolus* are about to moult or are simply resting between meals. The moult is, of course, a crucial time with all caterpillars, and in this case I had continual disappointments when I tried to bring them through in closed glass jars. I used this method in order to keep the delicate food fresh; I changed the jars daily, disinfecting and drying them, and provided new food daily from plants grown at home. In spite of all this I lost most of my larvae in their first moult after they were collected. In this air-tight method, which is so often successful in other cases, *Entada* may not keep as fresh as it seems, and this may have an effect on skin-changing. Even more likely, the constricted places into which the larvae get for their moult may be too damp for them at these times.

Whatever the reason, it was plain that an airy atmosphere, at the same time much damper than that of Poona, would have to be provided. So in 1963 I put larvae on the growing plant on the veranda in Poona confining them with cellophane sleeves. Air was brought in through a small panel of fine gauze, fixed with cellotape. The sleeves were open at both ends. First they were slipped over a suitable spray of young leaves and shoots. Then they were tied as tightly as possible at the bottom with strong thread. The larvae were dropped in through the top opening, which was folded over and shut with bulldog clips or paper clips. The contraption was then held upright by a string fixed to a support.

Apparently the cellophane sleeves gave approximately the atmosphere of the forest in the monsoon; 'sweat' and mould were avoided, and there were few deaths from any cause. When a larva was to be examined it could usually be located by opening the top of the sleeve. When it was ready to pupate it nearly always went down to the bottom end of the sleeve, but could usually be slid out of the top end into a dish, a safer way than opening the bottom end. As they are bad cannibals from the start, in captivity at least, they were sleeved separately.

Throughout their life these larvae are capable of dropping by a thread, but even when young they do not do so readily. On one occasion a leaflet I was cutting off with a larva on it fell to the jungle floor, and when I was lucky enough to spot the cutting the larva was still in position.

The larvae are well protected by resemblance to various parts of their food-plant. They are not conspicuous, even when green, on the yellowish tendrils—in the green stages they look astonishingly like leafbuds and stipules. When there are red lines above the legs these blend perfectly with the red borders of the young green leaflets.

The larvae will eat only tender leaves, whether red or green; green leaves which have grown a hard skin will not do. They like the terminal buds and the newly expanded leaves, also the yellowish shoots and tendrils. They live under the leaves a great deal. After the first moult or two they eat irregular holes right through from the mid-vein outwards. As *Entada* does not shoot again in the same place for a considerable time, it is a good thing to avoid cutting off the whole of a leading shoot in the excitement of collecting the larvae. Even in September and October there may not be many young growths, and several larvae were often found crowded together on one or two shoots.

Growth is rapid, as it must be with a larva which eats only the young leaves of a plant which does not produce them frequently. Notes from my 1963 records show this:

Eggs laid probably on 26 or 27 September were collected on 29th and produced larvae on 30th. These moulted about 2 October and had grown to 1.5 mm. in length. On 10 and 11 October larvae were found full grown in the sleeve. They pupated on 13th and three butterflies emerged on 21st, making 24 or 25 days from egg to imago.

As it is not possible to observe larvae in a sleeve closely, the following notes on the stages of growth are incomplete, but are nevertheless of interest as records of my first *pactolus* brought through from collected eggs:

8-9-1963	Eggs collected	In air-tight container
9-9-1963	Larvae emerged	
11-9-1963	First moult. Length 1.5 mm.	Transferred to cellophane sleeve
18-9-1963	Length 10 mm.	
19-9-1963	Length 11 mm.	
20-9-1963	Spun pad for pupation on the side of a zinc container, just above the earth	
23-9-1963	Pupation	
30-9-1963	Female emerged at 13.30 hours.	

The above seems to show that a moult occurs about every two days. As observed, the metamorphosis is usually accomplished in the short period of about 25 days.

Attendance by ants. I did not come across many ants on the *Entada* plants, and none attending anything, until on 1 October 1961 I found a *Camponotus* looking after a membracid. Shortly afterwards

I found two more *Camponotus* each actually attending a *pactolus* larva. One was stationed just behind its larva in the typical 'attending' posture, with waving antennae and a generally possessive air. It was a small black *Camponotus,* and when first seen with the larva had its abdomen tucked under the thorax. The other ant was sitting in a clump of leaflets which looked as if they had been drawn together by a spider, and from this hide it was keeping a close watch on a larva. It was a light brown ant, and moved deliberately except when alarmed, when it tried to elude me by a series of jerky spurts.

Later I saw the light-brown ant paying some attention to one of the larvae in captivity, without apparently getting any response. Apart from this the ants and the larvae seemed indifferent to one another. Presumably, therefore, *pactolus* is not dependent on ants. If it was, I should have expected the *Camponotus* to behave as I have seen them do, under similar conditions of captivity, with larvae of the genus *Tarucus—Camponotus* attended these continuously, without a thought for anything else, thriving on nourishment from the larvae right up to pupation. In such cases ants lose their normal desire to hurry back to the nest, and may be said to be demoralized. But with *pactolus* the two *Camponotus* were restless, and died in three days.

The ant relationship therefore appears to be intermittent, and probably is not essential for the health of the larva. However, the presence even of ants distracted by captivity may be good for the larvae. Certainly, five out of the six larvae found on 1-10-1961 did produce butterflies after having been kept with ants found with two of them. On the other hand, success may have been due entirely to the fact that these larvae had got safely through their moults.

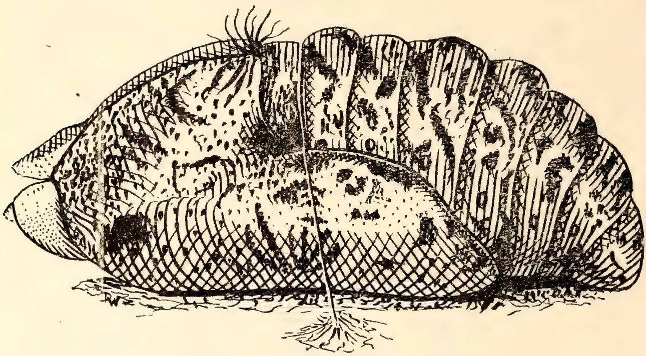
It is likely that other ants look after *pactolus* larvae; at various times I tried *Prenolepis* and a small yellow ant, probably a Cremastogaster, from about the house, and once saw response to the latter. The larva put out the organs of segment 8 and the ant rode on its back for a short time. I have caused the organs to evert by tickling with a small paint-brush.

No ant relationship is to be expected before the larvae reach the 'green stage'. Until then they are protected against dangers by the long bristles, and presumably have not developed their ant-glands.

Parasites. No larvae or pupae under observation seemed to have been parasitized by Hymenoptera or Diptera. If they were, the facts may become known when the larvae which died are dissected.

One nearly full-grown larva died after two very long worms had left its body. They are probably *Gordius*, as they got into a great tangle. They have been preserved with their host.

Pupa. This is of the normal Lycaenid shape, 'like a trussed chicken', and very like the other *Nacaduba* pupae I have seen (Text-fig. 3). My specimens were reddish brown in colour with dark spots and blotches. The drawing was done from a pupa skin, not unfortunately from the living pupa. The five 1961 pupae were all about the same size: length 10.5 mm., breadth at thorax 3 mm., and across the third somite of the abdomen and the wing cases about 4 mm.



Text-fig. 3. Pupa skin (diagrammatic)

A newly formed pupa had a pink abdomen, green wing-cases, and brown upper thorax. The dark blotches were visible but not prominent. The next day the wing-cases were yellow-ochre, and the abdomen still pinkish but inclining to brown.

Judging by the nineteen *pactolus* pupae I have seen, there is no marked difference between them and those of *N. beroe*, of which I have seen numbers and have specimens and skins for comparison. The former are slightly larger, and more robust in appearance; the ground colour is redder and the spots larger and darker.

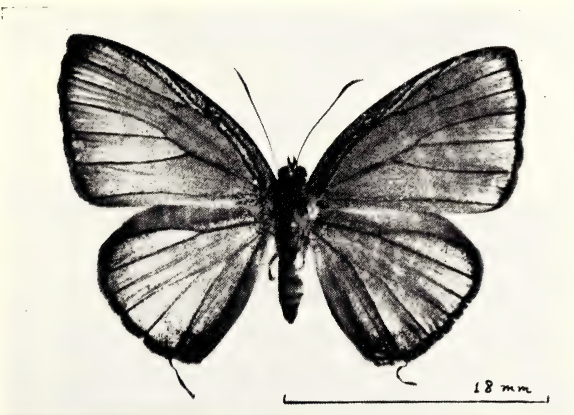
Before their change the five 1961 larvae took up the following positions: (1) on lower surface of a leaflet; (2) and (3) almost touching one another and in between two leaflets, near the petioles, and concealed from view—the leaflets were drawn together with bits of silk in an inefficient-looking manner; (4) on the upper surface of the same leaflet as No. 1; (5) on the bottom of a glass jar.

After spinning its pad and girdle a larva was 11 mm. long, purplish brown above and towards the front end, pinkish in the rear.

In 1963 the larvae were taken out of the sleeve when ready to pupate and placed in plastic cages with damp earth and dead leaves.

Nacaduba pactolus continentalis Früh.

Female : Upper side
(Caught specimen : 23–10–1960)



Male : Upper side
(From larva : 11–10–1960)

(*Photos : A. E. Bean*)

Nacaduba pactolus continentalis Früh.

Female : Under side
(Caught specimen : 23-10-1960)

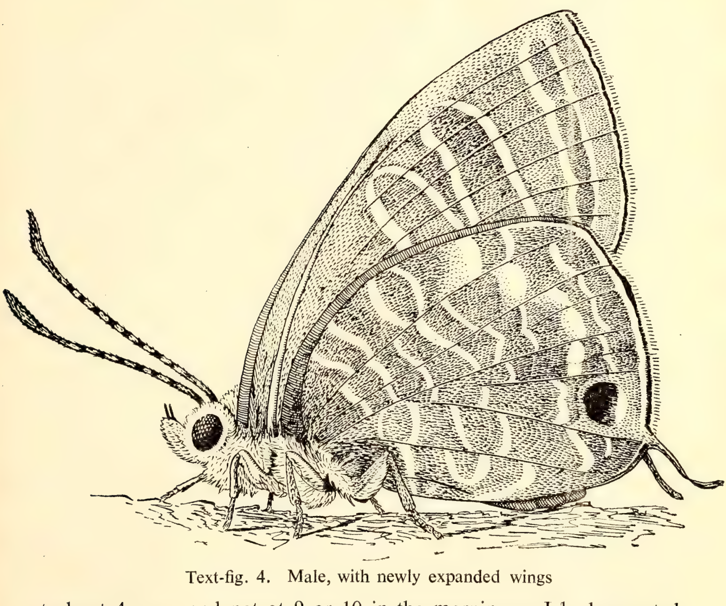
Male : Under side
(From larva : 11-10-1961)

(*Photos : A. E. Bean*)

Some spun up in the leaves, either merely in between them, or in a cocoon formed by drawing them together with silk. One formed its pupa, as noted above, on the side of the zinc bottom of the cage, just above the surface of the earth, and another right up under the lid.

Both in 1961 and in 1963 the pupa cages were kept in a conditioned atmosphere. This was simply a wooden box covered with a sheet of glass, containing a large zinc lid kept full of water. As a precaution against mould the water was treated with a tiny quantity of formaldehyde 40%, usually added when the water was renewed. The plastic cages themselves were sufficiently aerated, and the glass cover of the wooden box was not tight fitting. When the butterflies were due I was usually there to give them plenty of air for expanding their wings, but they did perfectly well without this attention. (See Oldroyd p. 70.)

Emergence of the Butterfly (Text-fig. 4 and Plates I-II). In 1961 the butterflies, all males, emerged in seven or eight days, all but one



Text-fig. 4. Male, with newly expanded wings

at about 4 p.m., and not at 9 or 10 in the morning as I had expected.

The two emergences in 1960 occurred at about 10 a.m. in sunny weather, but in 1961 the weather was damp and dull.

Before the butterfly comes out the pupa becomes much darker, which is of course the general rule. But in the case of *pactolus* the darkening occurs, apparently, the day before, and on the day of emergence the dark retreats to certain areas and the general colour gets much lighter again. It may be that this happens in other butterflies, but I had not been keen enough to notice such things until I had *pactolus*. In 1960, with only two pupae, I looked at them frequently, and on about the eighth day saw that one had turned very dark. Every time I had another look at it I expected to see the butterfly. By the end of the day I had given up hope. But in the morning the dark colour was redistributed, and to my surprise and delight a male butterfly came out.

In 1961 there were the same changes in colour, and as the butterflies came out later in the day it was more convenient for me. I made the following notes:

11-10-1961:

09.15 hrs. Pupa No. 4 is shining brownish black, the spiracles whitish brown.

12.15 hrs. A whitish patch has appeared on either side of the head. The wing-cases are more strongly demarcated because of an indentation which has appeared along their dorsal margin. The black ground colour shows up some short white hairs on the abdominal segments not noticed before.

13.15 hrs. The black has now retreated to a diffused dorsal line, leaving the rest of the surface brown, faintly marbled with darker, especially on the wing-cases. A lighter patch has appeared on segment 5 of the abdomen. The palpi now show as near-white streaks just below the eyes. The girdle seems tighter and more obvious.

14.00 hrs. A mite twice explored the pupa, especially around the head and wing-cases, but to my relief went off each time into some dead leaves.

I was fortunate in witnessing the butterfly actually come out of pupa No. 4. It happened very quickly at about 4 p.m. The wings expanded within five minutes, but for the first quarter of an hour some of the forewing remained hidden by the hindwing. After this the wings were held in the normal resting position of the genus, with most of the forewing showing.

These males soon became too restless for me to sketch them, but I got the pose of the example illustrated while the forewings were still drawn below the hindwings. The fresh specimens were a pretty sight; in one case I noticed some of the powdery stuff from

inside the pupa skin still clinging between the wings just above the thorax.

In 1963 six males and six females were reared, four from the egg. The same colour changes in the pupa were observed, but only in the case of males. Female pupae simply darkened and, shortly after, the butterflies came out.

A newly emerged male continued to wave its antennae simultaneously back and forth, as if sensing possible dangers, until the wings were expanded and in the 'pre-normal' position. After remaining still for some time it moved its antennae slightly, took a short step, and fluttered a little in the cage. Outside, this would have been its first flight, probably for only a short distance. The flight resulted in the grey powdery stuff from inside the pupa case, which had lodged on the thorax and between the wings, coming off in a cloud.

CONCLUSIONS

1. From rearing experiments and field study it seems that *Nacaduba pactolus continentalis* in the Khandala jungles is a monsoon and post-monsoon insect. I have not yet seen it there earlier than the third week in July or later than the first week in December.

It seems probable that it passes the intervening months as a pupa. The habit of the monsoon generations of pupating low down among dead leaves, where there is always a certain amount of humidity in the jungle, is a pointer in this direction but it has not been verified. No possibility can be ruled out. Thus, though the egg-laying habits described are against lying over in the egg, yet this could be the fact if the generation before the diapause had specialized habits. For instance a European *Argynnis* (Nymphalidae) has been found to lay its eggs in cracks in bark during the summer, the larvae emerging only in the following spring and finding their way down to their herbaceous food-plant at ground-level. I owe this point to Dr. D. Ilse.

Again, it is by no means impossible that the larvae lie over, remaining in the same kind of dampish situations as the pupae. They could even come out to feed at intervals, for the lianas have been noticed to sprout around January and after the first showers in April.

These possibilities can only wait for verification by lucky observations in the field, or by work with flight cages providing roughly natural conditions.

2. Another piece of field work which appeals to me would be to release a number of caught females in other suitable but not too

remote habitats which exist near the area in question. The population in here presumably dates back to remote antiquity. This is a solemn thought. Some accident, or human foolishness, or perversity could wipe out the one known remaining colony. So if the species is not detected elsewhere in the district, it would not be improper to try and plant it at a second accessible colony. It would be a fine thing to give this interesting and mysterious creature a greater chance of continuing its existence for we do not know if it has any strongholds deeper in the dwindling forests of the Bombay Ghats.

Acknowledgements

I thank Dr. I. H. H. Yarrow of the British Museum (Natural History), London, for confirming the genus of the ants found with *Nacaduba pactolus*. I am grateful to Mr. D. Whiteley of the Hope Department of Entomology, Oxford, for advice and help of the most practical kind with the line drawings. He was good enough to prepare figures from my sketches, in order to provide me with examples of how various effects are obtained in reproduction. Dr. T. Norman not only wrote the letter quoted from in the text, but sent a parcel of valuable material, including Assam examples of *Nacaduba pactolus*. I am very grateful to Father F. L. Wain, S.S.J.E., for taking the photographs of the adult insect, and for his unfailing encouragement.

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Studies on the Biology of some Freshwater Fishes

PART III—*Callichrous bimaculatus* (Bloch)

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(*With eight figures*)

[*Continued from Vol.* **61** (2): 347]

INTRODUCTION

Callichrous bimaculatus (Bloch) is generally a fish of running water. According to Day (1878) it is found in India, Ceylon, Burma, and Malay Archipelago. It grows to about one foot in length and is highly esteemed as food. It has often been referred as 'butter fish'. During monsoon months when fields and low-lying areas get flooded, it makes an access from rivers and irrigation channels to ponds and fields. Sometimes vast numbers come up from rivers and are caught in ponds by drag-net and cast-net after the monsoon season is over. Besides September, October, and November there is no other time when this fish is caught in ponds in and around Aligarh.

No account is available on the biology of this fish excepting short descriptions on its life-history (Rao 1919), occurrence of ovigerous females and larvae in Ceylon (Deraniyagala 1930), and record of its breeding in the River Mahanadi (Job *et al.* 1955).

Methods

The fishes examined in the course of this investigation came from the local fish market. Inquiries from the fishermen suggested that they are regularly caught along with major carp, murrel, and other fish in the rivers (Ganga, Jamuna, and Kali), irrigation channels, rainwater drains, and distributaries. The gear generally employed for their capture is drag-net, small meshed gill-net, and cast-net. The present study covers a period of two years, from October 1958 to September 1960. During the first year monthly samples obtained were rather small, so the investigation was extended for another year, and for all duplicate months the data have been grouped and are presented only for a period of 12 months. Owing to scarcity of specimens, several visits to the fish market were needed to obtain a substantial number of fishes in each month. The routine examination of each fish was the same as has been used for *O. punctatus* (Part I).

Length frequency distribution

Table XIII indicates the number of fishes according to their size groups in various months. The length frequency distribution of the fish has been illustrated as histograms in Fig. 17, after pooling the sample on a quarterly basis. In the figure the various year classes that could easily be judged have also been marked arbitrarily.

The histogram for the months October-December shows five groups. Due to lack of smaller fishes in these months a clear peak representing the 0 group fishes could not be obtained. However, the fact that the smallest fishes were obtained in these months clearly shows that these belong to the current year's brood. The breeding season of the fish being July and August (see page 648), the appearance of small fishes from October to December coincides well with the inference that these could only be the 0 group fishes. The 0 group fishes being thus established, the other modes demarcated in the histograms probably represent the I, II, III, and IV year classes. The average sizes of the various year classes as determined by their respective modes are as follows: 0 group = 9·3 cm., I group = 14·0 cm., II group = 20·8 cm., III group = 24·5 cm., and IV group = 27·8 cm.

In the histogram for the other three months (January-March), the progression of these year classes can easily be followed. The length frequencies of January to March show only four groups of fishes. In

these months there was a total absence of large-sized fishes and therefore the 5th mode probably belonging to four-year old fishes is

TABLE XIII

NUMBER OF FISH (*C. bimaculatus*) OF EACH LENGTH GROUP CAUGHT IN VARIOUS MONTHS

Length group	January	February	March	April	May	June	July	August	September	October	November	December
cm.												
7·0	..	..	..	..	..	..	..	..	..	..	..	..
7·5	..	..	..	..	..	..	..	..	..	..	3	..
8·0	..	..	..	..	..	..	..	..	..	..	2	..
8·5	..	..	..	..	..	..	..		..	..	4	..
9·0	..	..	..	1	..	..	..	..	..	..	8	2
9·5	..	..	..	1	2	2	2	..	..	..	6	4
10·0	2	..	4	..	..	3	3	..	2	3	7	8
10·5	1	..	3	2	2	..	..	1	1	1	5	9
11·0	1	..	6	3	4	5	4	3	1	4	2	10
11·5	2	1	1	2	5	7	6	1	4	5	3	11
12·0	2	..	3	6	2	2	5	..	10	3	6	8
12·5	1	..	1	1	3	..	2	5	3	8	3	6
13·0	8	..	..	1	2	4	..	5	3	7	3	..
13·5	7	..	..	1	3	..	..	7	..	9	9	1
14·0	10	..	..	2	2	2	..	8	..	2	10	1
14·5	14	..	..	1	..	3	..	2	3	11	8	..
15·0	8	..	..	3	..	..	..	4	4	10	12	..
15·5	9	..	..	1	3	1	..	3	6	10	9	1
16·0	8	7	..	..	3	..	4	..	9	5	7	..
16·5	3	..	..	2	..	..	..	..	11	..	5	..
17·0	4	2	..	1	..	3	..	1	11	..	6	..
17·5	1	..	6	2	1	6	..	1	5	1	5	..
18·0	3	..	..	2	5	1	2	2	7	3	1	..
18·5	2	..	..	1	1	..	3	2	8	..	..	..
19·0	3	..	..	1	2	2	3	3	3	2	..	..
19·5	..	..	2	..	..	3	1	3	1	..	4	..
20·0	3	2	..	1	2	1	..	2	1	1	6	..
20·5	1	..	3	..	4	..	3	..	..	..	1	3
21·0	..	..	5	..	..	3	..	1	..	..	..	6
21·5	..	..	6	..	..	2	..	2	..	..	..	4
22·0	..	2	4	1	1	4	..	4	..	..	..	5
22·5	..	1	4	..	3	1	2	1	1	..	..	1
23·0	..	2	4	3	..	..	2	..	3	..	..	1
23·5	..	1	2	..	..	2	1	..	..	..	..	2
24·0	..	1	2	3	..	..	1	1	1	..	..	3
24·5	2	2	..	..	1	..	..	..	2	..	..	1
25·0	..	3	..	..	..	2	..	..	1	..	..	2
25·5	..	1	..	1	..	..	..	..	2	..	..	..
26·0	..	..	2	..	2	..	3	..	..	..	..	1
26·5	..	1	..	..	..	1	2	1	1	..	..	2
27·0	..	1	..	..	..	..	3	..	..	..	..	1
27·5	..	..	..	..	..	..	1	..	..	..	..	4
28·0	..	..	..	..	..	1	..	..	..	..	..	3
28·5	..	..	..	..	..	1	..	2	..	..	..	1
29·0	..	..	..	..	..	..	..	1	..	..	..	..
29·5	..	..	..	..	..	..	..	..	..	..	..	1
Total ..	95	27	58	43	53	62	53	66	104	85	135	102

lacking. The average size of the preceding year classes 0 to III is approximately 11·2, 15·8, 21·0, and 25·2 cm. respectively.

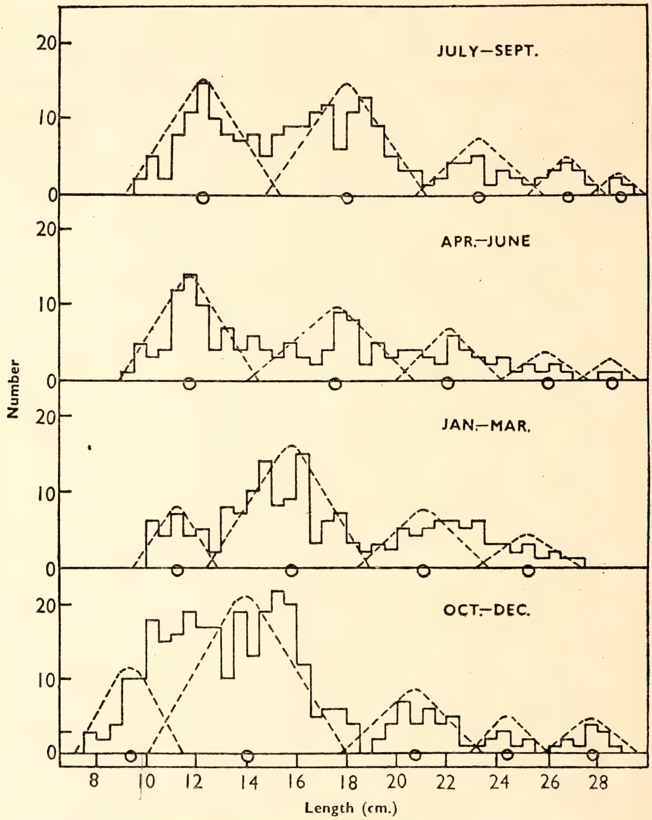

Fig. 17. Length frequency distribution of *C. bimaculatus*

Open circles denote average length of various year classes as indicated by modes. Modes marked by broken lines.

In the histogram for April to June there are five modes representing 0, I, II, III, and IV year classes. Their average size is 11·7, 17·5, 22·0, 26·0, and 28·5 cm. respectively.

The histogram representing July to September also shows five distinct modes. The first with a modal size at 12·2 cm. has just

completed one year as they were born during the corresponding period of the preceding year. Similarly in other year classes which have reached the end of each year's life, the sizes attained are as follows: 2nd year = 18·0 cm., 3rd year = 23·2 .cm., 4th year = 26·8 cm., and 5th year = 28·9 cm.

TABLE XIV

AVERAGE LENGTH OF VARIOUS YEAR CLASSES OF *C. bimaculatus* OBTAINED FROM THE LENGTH FREQUENCY DISTRIBUTION OF VARIOUS QUARTERS TOGETHER WITH THE SIZE RANGE OF EACH YEAR CLASS

Year classes	Months	Range in size, cm.	Average length, cm.
	October-December	7·2-11·4	9·3
	January-March	9·5-12·8	11·2
0	April-June	9·0-14·5	11·7
	July-September	9·2-15·3	12·2
	October-December	10·0-18·0	14·0
	January-March	12·0-18·9	15·8
1	April-June	14·0-20·8	17·5
	July-September	14·8-21·0	18·0
	October-December	17·8-23·4	20·8
	January-March	18·4-23·7	21·0
2	April-June	19·9-24·2	22·0
	July-September	20·8-25·7	23·2
	October-December	22·9-26.0	24·5
	January-March	23·2-27·2	25·2
3	April-June	24·0-27·6	26·0
	July-September	25·3-28·2	26·8
	October-December	25·8-29·7	27·8
	January-March	— — —	—
4	April-June	27·1-29·6	28·5
	July-September	27·8-29·7	28·9

Table XIV gives the average sizes of each year class as revealed by the quarterly histograms in various seasons. It is evident from the table that the increase in length during the first year is about 12 cm. During 2nd, 3rd, 4th, and 5th years the increases in length are 6·0, 4·5, 4·0, and 2·5 cm. respectively. In the first year the growth rate is considerably fast. It slows down progressively in subsequent years. In all size groups, growth continues to occur throughout the year.

BREEDING

(*a*) *Stages of maturity*

All fishes were sexed and grouped according to the conventional five maturity stages (see Part I). During maturation the gonads of

TABLE XV

MATURITY STAGES IN VARIOUS LENGTH GROUPS OF *C. bimaculatus*

Maturity Stages		Length in cm.→ 7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0	22.0	23.0	24.0	25.0	26.0	27.0	28.0	29.0
MALE	I.	2	5	16	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	II.	..	..	..	15	17	12	21	25	27	14	12	5	3	8	5	4	2	3	1	1	..	..	..
	III.	..	..	..	1	2	6	2	2	4	3	2	3	..	1	2	1	2	1	..	1	..	..	..
	IV.	..	..	..	5	14	4	1	2	2	2	5	5	8	3	5	4	2	..	..	1	..	..	..
	V.	..	..	..	1	2	9	..	..	8	8	7	6	5	1	..	2	1	1	1	1	..	..	..
FEMALE	I.	1	1	12	31	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	II.	..	..	..	2	33	34	23	31	32	21	13	4	8	12	11	12	10	6	5	6	6	4	2
	III.	..	..	..	..	8	1	5	3	3	2	2	3	2	5	3	3	1	3	1	..	..	..	..
	IV.	..	..	..	..	12	10	14	11	3	2	6	4	4	2	3	6	2	2	2	5	4	4	..
	V.	..	..	..	..	3	4	4	5	5	12	9	13	3	2	..	3	3	2	2	1	..	4	..

this fish undergo marked changes in form, colour, etc. which can be summarised as follows: In immature fishes (Stage I) the ovaries are small, sausage-shaped, translucent, and buff-coloured, while the testes are ribbon-like, white, and transparent. The maturing virgins or recovered spent fishes (Stage II) have enlarged, sac-like, translucent, and dull-pink-coloured ovaries. In these fishes the eggs are invisible to the naked eye. The testes are slightly coiled, white, and translucent. In ripening fishes (Stage III) the ovaries are considerably enlarged, opaque, and light yellow in colour. Eggs in females become visible to the naked eye while in males the testes are opaque, distinctly coiled, and white. In ripe fishes (Stage IV) ovaries are very much distended and occupy the entire body cavity. They are yellow in colour and contain large opaque eggs. In males the testes are greatly coiled, opaque, and pale white. In spent fishes (Stage V) ovaries are collapsed, flesh-coloured, while the testes are shrunken and dull-white.

(*b*) *Size at first maturity*

The various size groups falling in each maturity stage throughout the period of observation are given in Table XV. It can be seen from the table that, in both sexes, all fishes up to 9 cm. were classed as immature. In 10 cm. group higher stages of maturity begin to appear. In males all the five stages were seen in this size group but in females there was no further advance beyond stage II. At 11 cm. length in females all maturity stages from II to V were recorded. It therefore appears that males mature at a size smaller than the females. The smallest ripe male and female were of 10·3 cm. and 11·1 cm. respectively. If these sizes are compared with the length frequency distribution it would appear that both sexes attain maturity when they have completed the first year of life.

(*c*) *Sex ratio*

The ratio between females and males was 1:0·65, as out of the total of 881 fishes sexed 532 were females and 349 were males. If the sex ratios are examined from month to month practically the same figure is obtained, indicating that this ratio remains more or less persistent throughout the year. The largest male was 26·0 cm. and female 29·5 cm. This suggests that either the longevity in males is less or they grow at a relatively slower rate.

(*d*) *Spawning cycle*

The number of fishes at each of the five maturity stages are shown month by month in Table XVI and the monthly percentages are illustrated diagrammatically in Fig. 18. It can be seen from the figure that

gonads show a regular seasonal change and that there is hardly any overlap between various maturity stages. The gonads of all fishes

TABLE XVI

NUMBER OF FISH (*C. bimaculatus*) AT EACH OF THE FIVE MATURITY STAGES IN EACH MONTH

Month	Sex	Maturity Stages					Total
		I	II	III	IV	V	
July	Male	..	..	..	18	3	21
	Female	4	..	..	25	3	32
August	Male	..	..	..	15	4	19
	Female	..	..	..	35	12	47
September	Male	..	..	..	..	46	46
	Female	2	..	..	..	56	58
October	Male	2	39	..	..	..	41
	Female	2	42	..	..	..	44
November	Male	18	42	..	..	..	60
	Female	14	61	..	..	..	75
December	Male	4	22	..	..	..	26
	Female	11	65	..	..	..	76
January	Male	..	42	..	..	..	42
	Female	3	48	..	..	..	51
February	Male	..	9	..	..	..	9
	Female	..	18	..	..	..	18
March	Male	..	17	3	..	..	20
	Female	..	35	3	..	..	38
April	Male	1	4	13	..	..	18
	Female	3	6	16	..	..	25
May	Male	..	..	17	5	..	22
	Female	3	..	26	2	..	31
June	Male	..	..	..	25	..	25
	Female	3	..	..	34	..	37
Total	Male	25	175	33	63	53	349
	Female	45	275	45	96	71	532

which are likely to spawn during the forthcoming breeding season recover fully in February and March. This is soon followed by the ripening stage in April and May. In June most of the fishes are ripe, and from July spent fishes begin to appear. In August the proportion of spent fishes increases, and by September the entire population

contains nothing but spent fishes. The occurrence of spent fishes in late July shows the commencement of spawning in this month. Their progressive increase in August and September and the total absence of ripe fishes in September indicate that the spawning is restricted to July and August only.

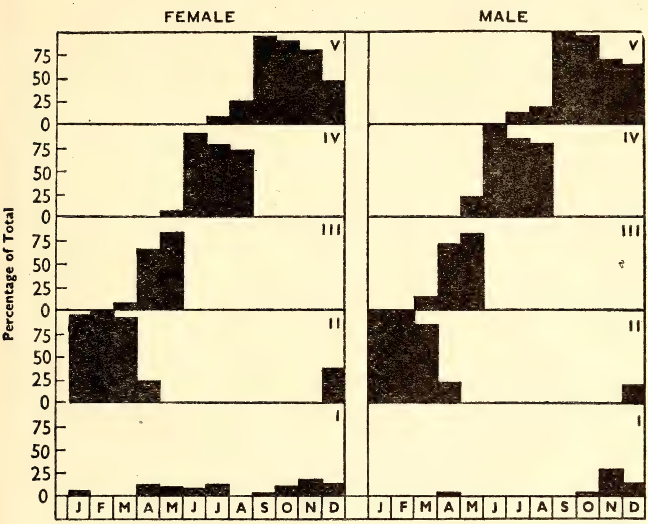

Fig. 18. Monthly percentages of *C. bimaculatus* at each of the five maturity stages during different months

(*e*) *Seasonal changes in gonad weight*

Seasonal changes in the gonad weight of both sexes were also recorded. These have been given in Fig. 19 as percentages of body weight. In the testes there was no significant change in weight until May. The maximum weight of testes was recorded in June when they were mostly ripe and from July there was a decline in testes weight, which reached its minimum in September. After September there was hardly any rise in testes weight until the following April.

In females the slow recovery of the ovaries was accompanied by no change in weight until December. In January the ovaries begin to gain weight, and from April to June there occurs a tremendous change in their size and weight. The maximum figure is rapidly attained in June, from July the decrease in weight becomes obvious, and by

September it reaches its minimum. Such a rapid rise in the weight of the ovaries and its sudden fall during the two months (July and

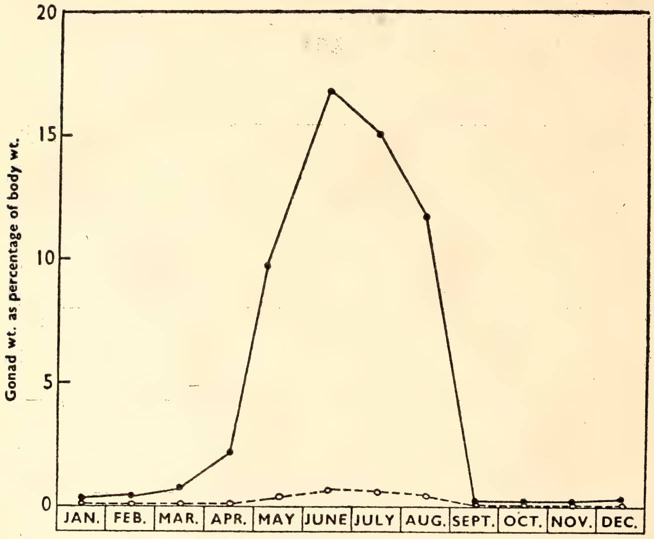

Fig. 19. Seasonal variation in the gonad weight as percentage of body weight of *C. bimaculatus*

Of females, continuous line ; of males, broken line

August) give a clear indication that the spawning season is very short and in all probability lasts for two months only, July and August.

(f) Spawning periodicity

Ova diameter frequencies have indicated that the ovaries of this fish contain a single group of eggs. In ripe fishes this group of large oocytes is widely separated from the much smaller yolkless cells (Qasim & Qayyum 1961). To determine whether all the large ova are shed in one spawning act or whether there is a spawning periodicity, the progression of the intra-ovarian eggs was studied during the pre-spawning and spawning months. Ova diameter frequencies from April to June are given in Fig. 20. It can be seen from the figure that in April, when fishes have reached the ripening stage, the stock of ova which are likely to be spawned during the forthcoming breeding season begins to get differentiated. The size of all these ova

ranges from 0·5 to 0·85 mm. In May the single batch thus demarcated gets more distinct, and in June when fishes attain peak maturity this batch becomes widely separated from the immature eggs which probably form stocks of later years. The size of the ripe ova ranges from 0·75 mm. to 1·25 mm. Spent fishes obtained in late July contain no eggs in their ovaries besides the immature eggs which measure about 0·25 mm. This clearly indicates that the entire batch of ripe ova is spawned and that there is no possibility of each individual spawning more than once during the breeding season. As has been noted elsewhere (Qasim & Qayyum 1961) in all such fishes where

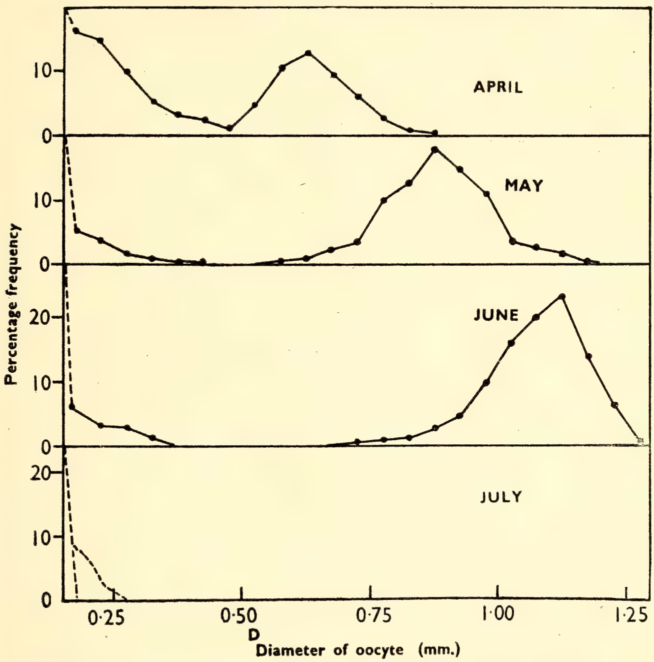

Fig. 20. Size frequency distribution of maturing oocytes of *C. bimaculatus* from April to July

a single group of ova is matured and shed, the duration of spawning in each individual is very short. Since the spawning of all the individuals of the population is well synchronised, the spawning season of the species lasts only for about two months.

(g) *Condition factor*

The formula for calculating the 'condition factor' of the fish was the same as used in *O. punctatus* and *B. stigma*, i.e. $K = \frac{W \times 100}{L^3}$. The K value of each fish in each month was calculated and the data for all the individuals in various months were pooled to find the arithmetical mean values of each size group and for each month. The former have been plotted in Fig. 21 and the latter in Fig. 22. It is clear from Fig. 21 that with the increase in length the K values continue to increase up to 20 cm. in males and up to 22 cm. in females. From these size groups onwards there is a progressive decline in the K values of both sexes. The points of inflection in the curves of both sexes, at 20 cm. in males and 22 cm. in females, do not correspond to the size at first maturity as determined by the changes in the gonad maturity. That the secondary decline in large fishes is due to increasing metabolic strain of spawning as has been

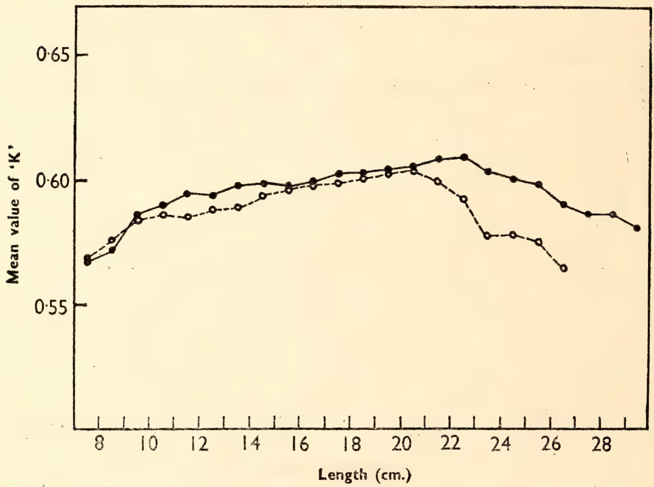

Fig. 21. Mean condition factor (K) of *C. bimaculatus* at different length groups

Of females, continuous line ; of males, broken line

indicated in many other species (Hart 1946; Menon 1950) seems very likely. Because, if the rate of increase of K with the size of fish is taken as a criterion of 'metabolic strain', then it would appear from

the figure that after the maturity is attained, which is at 10-11 cm., the increase in K becomes less rapid. A similar feature in the condition factor has been noticed in *O. punctatus* (Part I).

Fig. 22 gives the monthly K values of both sexes. In calculating the mean, immature fishes which were smaller than 10 cm. have been omitted from the sample. As can be seen from the figure, in females the seasonal cycle of condition factor is better defined than in males (Fig. 22). Maximum K value for females is obtained in June which corresponds to the maximum figures recorded for the gonad weight. Its decline in July, August, and September seems entirely due to spawning. In males, on the other hand, maximum K value is obtained in May. This does not correspond entirely to changes in the gonad weight because the gonad weight is highest in June. Probably it is because of general building up of reserves before spawning that the K value records its highest in May. A decrease in K value in June when peak maturity is attained is presumably because of utilisation of body reserves towards gonad building in males. The cycle of the condition factor seems entirely connected with the maturation of the gonads and spawning in both sexes however.

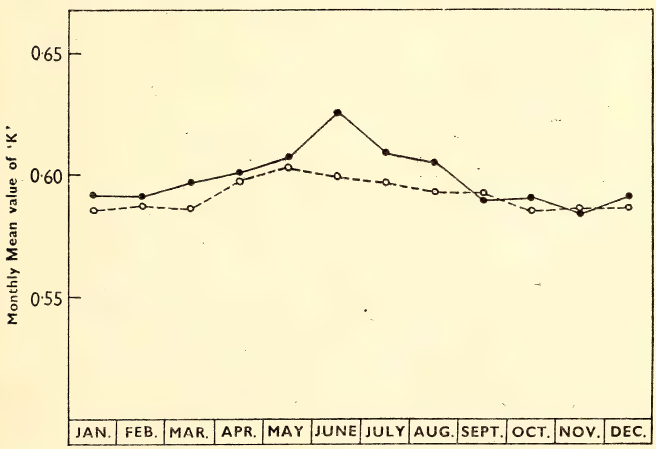

Fig. 22. Seasonal variation in condition factor (K) of *C. bimaculatus*
Of females, continuous line ; of males, broken line

Food

(a) Food of all size groups

Nothing is known about the food of *C. bimaculatus*. The present investigation which is based on the gut content analysis of 881 fishes

TABLE XVII

PERCENTAGE OCCURRENCE OF VARIOUS CATEGORIES OF FOOD IN THE GUTS OF *C. bimaculatus*

Months→	January	February	March	April	May	June	July	August	September	October	November	December
No. of fish examined..	93	27	58	43	53	62	53	66	104	85	135	102
No. of fish with food..	57	19	39	31	39	43	31	38	97	76	98	66
Barbus ticto ..	38·5	47.3	53·8	58.0	48·7	41·8	25·8	26.3	37·1	64·4	56·1	46·9
B. conchonius ..	25·0	15·6	28·1	25.8	22·8	6.9	28·9	42·0	52·0	31·4	71·3	24·1
B. stigma ..	..	..	..	12.9	20.5	9·3	..	..	14·4	..	..	..
E. danricus ..	..	5·2	..	12.9	..	11·6	..	..	..	..	..	..
Chela sp. ..	..	..	..	3.2	..	..	..	..	..	..	..	..
Trichogaster sp. ..	..	..	2·5	..	..	2·3	3·2	..	..	..	..	..
Mystus sp. ..	..	..	..	..	..	..	..	..	1·0	..	..	..
Amblypharyngodon sp.	..	..	..	..	..	..	3·2	..	1·0	1·3	..	..
Rohtee cotio ..	..	..	..	..	..	..	6·4	2·6	2·0	..	1·0	..
Digested fish ..	3·5	..	4·7	..	5·0	2·3	..	..	6·0	3·9	8·1	6·0
Orthoptera ..	..	..	..	..	..	..	32·2	44·7	16·3	23·6	26·5	6·0
Hymenoptera ..	9·3	..	..	..	..	..	19·3	23·6	22·2	26·2	16·3	3·0
Coleoptera ..	7·0	5·2	..	13·0	2·5	4·6	6·4	10·5	5.1	2·6	6·1	3·0
Odonata ..	14·0	20·8	4·7	6·5	2·5	..	..	..	3·1	5·2	..	3·0
Hemiptera ..	1·7	5·2	7·5	6·5	4.7	4·6	6.4	7·8	..	..	2·0	4·5
Ephemeroptera ..	..	..	..	..	..	..	..	2·6	1·0	..	..	3·0
Plecoptera ..	..	..	..	6·5	2·5	..	..	..	..	..	..	..
Digested insects ..	1·7	..	4·7	12·9	2·5	2·3	..	2·6	4·0	3·9	2·0	..
Mucous ..	..	..	9.4	..	..	..	1·6	2·6	5·1	7·8	10·2	4·5
Prawn ..	3·5	10·4	4.7	3·2	2·5	..	3·2	..	1·0	1·3	..	..

clearly illustrates the nature of the food and its variation from month to month. Out of the total number of fishes examined, 267 had no food in their guts. The percentage composition of various items of food in the gut from month to month is given in Table XVII. As

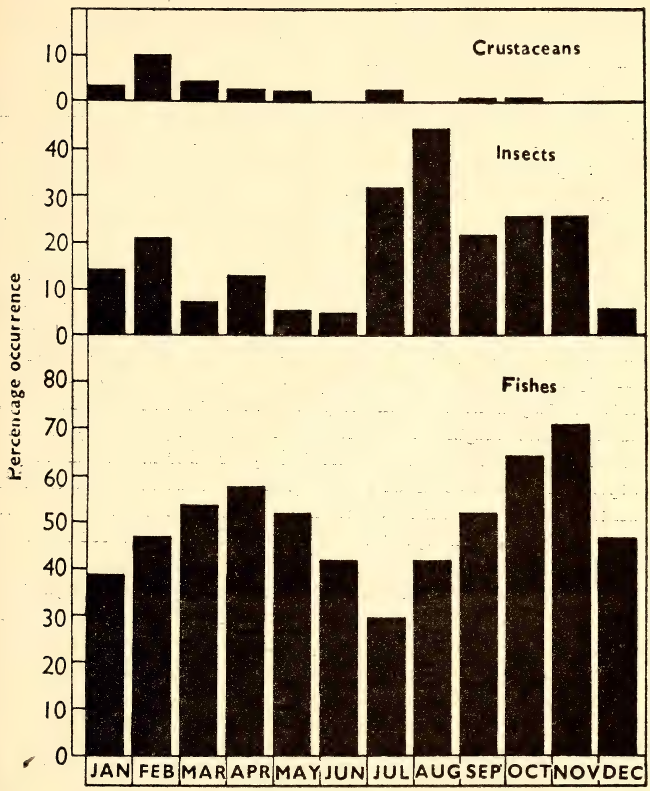

Fig. 23. Relative occurrence of three important food items of *C. bimaculatus* in different months

can be seen from the table, fish and insects form the main food. The occurrence of these two groups in various months is shown in Fig. 23, together with crustaceans (prawns) which form food of lesser importance.

Fish occurred in nearly 66% guts. Maximum numbers containing fish were recorded in October and November. In these months, sometimes as many as six fishes were found in a single gut. From April to July the occurrence of fish in the gut progressively falls. This may be connected with the maturation of gonads, because in *C. bimaculatus* April to July are the main months when peak maturity is attained. Probably during this period the fish becomes less active and fails to catch other fishes.

In all, nine species of fish were recorded from the guts. Of these, *Barbus ticto* and *B. conchonius* were most abundant. The former occurred in the largest number of guts whereas the latter came next. Other species ingested were *B. stigma, Esomus danricus, Chela* sp., *Trichogaster* sp., *Amblypharyngodon mola, Mystus* sp., and *Rohtee cotio.* These were relatively in small proportions and occurred only in some months of the year (Table XVII).

Insects formed the other important item of food. These included both terrestrial and aquatic species. Terrestrial insects were grasshoppers, ants, and beetles, whereas aquatic insects belonged to the Orders Coleoptera, Odonata, Hemiptera, and Ephemeroptera. Orthopterous insects were not regularly found in the gut. They were recorded only in the monsoon and post-monsoon months (July-December). In July and August they were found in nearly 40% guts. Ants (Hymenoptera) also occurred from July to December. In August, September, and October ants were quite abundant in the guts. Some fishes contained as many as 30 ants. Terrestrial beetles were comparatively rare although they did occur in the monsoon months. Aquatic beetles (Dytiscidae), on the other hand, occurred practically throughout the year. The occurrence of terrestrial insects (grasshoppers, ants, and beetles) in a large number of guts was at first rather surprising but, since they started appearing from the monsoon months, it became obvious that they must have been carried to the rivers from land along with the rain-water.

The other aquatic insects such as dragonfly nymphs occurred in small proportions, but during winter months (January and February) they became fairly common in the gut. *Corixa* sp., *Notonecta* sp., and *Gerris* sp. formed the aquatic hemipterous group of insects. *Corixa* and *Notonecta* were common throughout the year. Occasionally *Gerris* and *Hydrophylid* insects were also seen. Ephemeroptera nymphs and Plecopterous insects were also recorded in a few guts on two or three occasions.

Crustaceans were rarely seen in the gut. The only organism which made frequent appearance in the diet was prawn. Since it

appeared as fragments or as digested remains it was impossible to identify the species.

The nature of the food of *C. bimaculatus* clearly shows that this fish is highly predaceous and subsists mainly on fish and insects. In *C. pabda,* which is closely related to *C. bimaculatus* systematically, some investigations have been made on the food. According to Mookerjee *et al.* (1946b), its food in Bengal consists of algae, protozoans, and crustaceans. The same fish at Lucknow has been found to feed on insects, fish, higher aquatic weeds, molluscs, unicellular algae, and crustaceans (Das & Moitra 1955). The food for *C. bimaculatus,* therefore, differs considerably from that of *C. pabda* as no aquatic weeds, algae, or molluscs were recorded during the present investigation.

From the various items of food ingested it appears that *C. bimaculatus* is more or less a surface feeder. Since its food includes a variety of fishes, it seems that this species is capable of feeding in the entire pelagic zone. The rarity in the gut of crustaceans and other organisms which are otherwise common in rivers provides some evidence that *C. bimaculatus* is a selective feeder.

(*b*) *Seasonal variation in the rate of feeding*

The feeding rhythm of the fish in different months has been shown in Fig. 24. It can be seen from the figure that two periods of intensive feeding are clearly marked. One lasts from September to November and the other from March to June. The only time when feeding

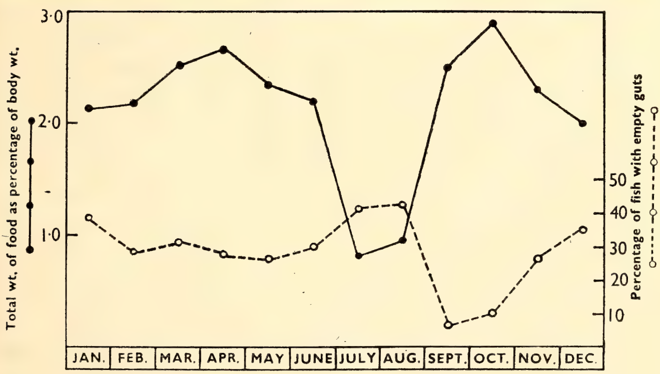

Fig. 24. Seasonal variation in the rate of feeding of *C. bimaculatus*

showed a considerable reduction was during July and August. These being the spawning months, the marked reduction in feeding is probably due to peak maturity and spawning. The other time when

feeding shows a slight decrease is from December to February. This may have been due to the low temperature conditions prevailing in the winter of northern India.

Freshwater environment and the biology of fishes

In India freshwater environment provides great diversity in physical, chemical, and biological conditions from season to season and from one part of the country to the other. Whether it is a lotic (running) or a lentic (static) environment, the biotic potential of any body of water depends upon its standing crop of organisms. These organisms are mainly composed of five large groups: (1) phytoplankton, (2) bottom flora, (3) bottom fauna, (4) zooplankton, (5) fishes. The first two constitute a producing cycle and the other three form a consuming cycle (Welch 1952). These features establish a complex interrelationship in the form of a nutritional chain in water (Darnell 1958, 1961).

In India the inland waters are teeming with life (George 1961) but, since no estimations have been made of the total productivity, it is difficult to say how it would vary in a given time or from one environment to the other. The work that can be carried out on plants and animals of a freshwater environment is of great significance and will go a long way towards reaching an understanding of the complex interrelationship between animal and plant communities. There are indications that these relationships may eventually change into mathematical aggregates (Lindeman 1942; Hazelwood & Parker 1963). At present owing to the newness of the subject it is difficult to attempt any generalisation and whatever is said must be regarded as only suggestive.

The foregoing accounts of the biology of three species (Part I-III) indicate that fishes, whether living in ponds or rivers, undergo progressive and predictable changes. Some of these changes are inevitable and inherent and could be appraised by carefully planned studies. Out of the three species investigated, two (*O. punctatus* and *B. stigma*) came from ponds and the third (*C. bimaculatus*) came from rivers. The pond fishes were particularly favourable material for research because they were not only common but easy to collect in fairly large numbers at all times of the year and practically all stages in their lives.

In all the three species, the length frequency distribution gave evidence of modes probably representing various year classes, on the

basis of which an estimate of the growth rate could be made. Breeding in each species was adapted to an annual rhythm. The cycles of maturation and depletion of the gonads were fairly regular and were repeated almost at the same time every year. Each species attained maturity by the end of the first year of life. The duration of their breeding was dependent upon the frequency of spawning. In *O. punctatus* which spawned repeatedly the breeding season was long, whereas in the other two species, *B. stigma* and *C. bimaculatus*, each individual spawned once only and their breeding seasons were relatively short. Breeding in ponds was non-synchronous. In some ponds the spawning occurred earlier during the season, whereas in others it was delayed or even inhibited. Probably the amount of repressive factor present in ponds (Swingle 1956) governed the spawning of fishes. Breeding seasons, however, coincided with monsoon and post-monsoon months. Feeding rhythm in all the species varied from season to season. The quality and quantity of the food consumed was influenced by physical factors (temperature and rainfall) and biological factors (gonad maturity and spawning). The food of *B. stigma* consisted of plankton organisms, algae, and organic debris. *O. punctatus*, though it fed on other aquatic organisms and fishes, showed a strong preference for *B. stigma*. *C. bimaculatus* fed chiefly on forage fishes including *B. stigma*.

It is therefore evident that in an environment for the maintenance of life processes a fish becomes a part of the complex interrelationship between animal and plant communities. Such a relationship has already been described in many tropical lakes (Fryer 1959). In a static environment (pond) a fish population gets very limited by interspecific competition which may be for food, for space, or for breeding (Rounsefell & Everhart 1953). In tropical latitudes the fauna and flora of a freshwater environment are extremely diverse (Hickling 1961, 1962). Their qualitative and quantitative variations are dependent upon seasonal exigencies such as winter, summer, and monsoon.

Age determination

While this work was in progress, no method of age determination was known in any of the species under investigation. The authors therefore conducted their studies on the growth of each species entirely on the basis of length-frequency distribution. Since the work was completed, the occurrence of growth zones on the opercular bones of

O. punctatus has been discovered (Qasim & Bhatt 1963) and it may be of interest to note that the mean lengths of the various year classes determined by the zones of the opercular bones agree closely with the average sizes determined from the various modes of the length-frequency distribution (Table II, at **61** (1) : 79). So the deduction made in this paper that the various modes correspond to year classes, at least in *O. punctatus*, seems correct.

Summary

Studies on the biology of three common freshwater fishes, namely *Ophicephalus punctatus*, *Barbus stigma*, and *Callichrous bimaculatus*, have been described in three different parts as follows:

I. *Ophicephalus punctatus*

A close examination of the length frequency curves, based on quarterly data, revealed distinct modes which evidently correspond to three or four year classes. By taking the average size of each year class, the growth rate of the fish can be estimated. Growth seems rapid during the first year. It slows down progressively in subsequent years as the fish grows older.

Both sexes mature when 11 cm. in length and begin to spawn when about one year old. The breeding season lasts from June to October. Testes are subjected to far less changes in weight than the ovaries. The maximum weight of the gonads in both sexes is obtained in June which corresponds to peak maturity. The ovaries of maturing fishes show two groups of ova which are expelled from the ovaries successively during the spawning months. Larvae are of common occurrence from July to October.

The values of the 'condition factor' (K) increase with the length of the fish up to 19 cm. From then onwards there is a secondary fall in the K values of both sexes. A seasonal cycle in the condition factor is well defined in both sexes. High and low values obtained in the various months correspond to seasonal changes in the gonad condition and feeding rhythm of the fish.

The food of *O. punctatus* varies according to the size of the fish. The adolescent and older fishes feed on fish, insects, and other aquatic organisms. Immature fishes consume mainly insects and crustaceans. The larvae of this species are mainly plankton feeders.

The total intake of food in larger fishes varies in different months. There are two periods of active feeding each year. Immature fishes continue to feed practically at the same rate throughout the year.

II. *Barbus stigma*

Length frequency distribution of *B. stigma* discerns at the most two to three year classes. A progression of these year classes in various quarterly seasons has been studied to determine the growth of the fish.

The fish attains sexual maturity when about 7·0 cm. in length. At first maturity the males are generally smaller than the females. The spawning season lasts from June to September. There is a single group of ova present in the maturing ovary which suggests that the cycle of spawning in each individual occurs only once a year. The condition factor of the fish increases with the increase in length and there is no secondary decline in large-sized fishes, which may be attributed to the onset of maturity. In both sexes there is a regular seasonal cycle in the condition factor which seems to be governed by the seasonal changes in gonad weight.

The food of the fish consists of a variety of animal and vegetable organisms. Organic debris, sand, and mud are also ingested in large quantities. There is no marked difference in feeding intensity from season to season. The fish feeds actively in all months of the year excepting November and December when there occurs a slight decrease.

III. *Callichrous bimaculatus*

Modes representing four to five year classes can be recognized from the quarterly size frequency histograms. The growth in length in the first year is about 12 cm. whereas during the 2nd, 3rd, 4th, and 5th years it is approximately 6·0, 4·5, 4·0, and 2·5 cm. respectively.

Both sexes spawn for the first time after they have completed their first year of life. Males at this age attain a length of 10 cm. and the females about 11 cm. The spawning season is short and lasts for about two months, July-August. Both sexes show regular seasonal changes in their gonads and the spawning is well synchronized throughout the population. Ova-diameter frequency distribution reveals only one group of oocytes in ripening and ripe ovaries which seems to be

shed in a single spawning act. The seasonal cycle in the 'condition factor' is better defined in females than in males. The maximum value for males is obtained in May and for females in June. The mean K values obtained for each length group gave some indication of the size at first maturity.

The food of this species consists of fish and insects. There are two periods of intensive feeding. The minimum quantity of food is consumed in July and August when most of the fishes have ripe gonads.

The interrelationship of fishes and freshwater environment is discussed in the light of studies on the biology of *O. punctatus, B. stigma,* and *C. bimaculatus.*

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Medicinal Plants of commercial importance found wild in Uttar Pradesh and their distribution

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The State of Uttar Pradesh stretches from latitude 24°N. to 31.25°N. and from longitude 77°E. to 84.50°E. approximately. The climate and physical features of the State present a variety and exercise an important influence in determining its vegetation.

The north-western part of Uttar Pradesh extends into the Himalayan and sub-Himalayan regions, and a small strip along the south forms part of the Central Indian Plateau. But the largest part of the State lies in the great Ganges Plain.

The Himalayan Region includes roughly all the land over 5000 ft. and has a rich and varied natural vegetation. The forests are dense and contain many different plants. This region catches the full force of the south-west monsoon and the rainfall is very heavy—more than 100 inches in the east. As we go westwards it gets less and less, but everywhere it is good.

The sub-Himalayan Region comprises the foothills between the plains and the mountains as well as the lower slopes of the Himalayas up to 5000 ft. The part nearer the mountains consists of a belt of hills, which is damp and covered with forests. The part nearer the plains, is often covered with coarse tall grass.

The Ganges valley is a vast plain without a hill. Running roughly through the centre from north-west to south-east is the Ganges. The plains are cold in the cold season, but get very hot in the hot weather and the rainfall is nearly everywhere less than 40 inches. There are no forests at all and most of the land is given to cultivation.

SURVEY OF MEDICINAL PLANTS

Under the auspices of the Indian Council of Agricultural Research and the Council of Scientific and Industrial Research, an all-India survey of medicinal plants was started more than 25 years ago. In this

connection the author undertook intensive botanical explorations all over the country, both in the hills as well as the plains, and tried to study, as thoroughly as possible, the areas and places where exactly such materials are to be found growing wild by collecting authentic specimens of medicinal plants. In addition the specimens of medicinal plants preserved in some of the important herbaria in the country such as the Forest Research Institute, Dehra Dun, and the Botanical Garden, Sibpur, Calcutta, were scrutinized for the purpose of finding out the exact localities of their collection. The relevant literature was also consulted.

The results of this survey show that a good number of medicinal plants of commercial importance, yielding products used as crude drugs, occur wild within the boundaries of the State of Uttar Pradesh. These vegetable resources can be exploited for the development of medicinal plants and crude drug industry in the State and can be utilized by the various medical and allied industries. The demand for a number of crude drugs for consumption in the State can be met to a great extent by collection from wild sources.

In order to facilitate the collection of these medicinal plants from wild sources, by drug collectors, drug dealers, research workers, commercial concerns, and others interested in their collection and utilization, the author has thought it necessary to record his findings, so that these may be readily available for reference. The data relating to the botanical names of these medicinal plants, their trade/Indian names, the part or parts used as crude drugs, along with their distribution, i.e. the areas and places where these plants are found growing wild in Uttar Pradesh, are presented below:

No.	Botanical name of plant	Trade/Indian name	Part or parts used as crude drug	Areas and places where found wild in Uttar Pradesh
1.	*Acacia arabica* Willd. (Medium-sized tree)	Babul, Kikar	Bark, gum	Naturalized in the plains and chiefly seen on village sites, borders of fields, canal embankments, or wastelands. Dehra Dun; Gola, Kheri Dist.; Jawalapur, Saharanpur Dist.; Ranipur, Saharanpur Dist.; Saharanpur Siwaliks; Tira, Saharanpur Dist.
2.	*Aconitum deinorrhizum* Stapf (Biennial herb)	Dudhia-bish, Mohra	Root	Alpine belt of the Himalayas of Garhwal at 12,000-16,000 ft. Kuari Pass (12,000-13,000 ft.), Garhwal.
3.	*A. falconeri* Stapf (Biennial herb)	Bish, Meetha-tellia	Root	Sub-alpine and alpine zones of the Garhwal Himalayas. Gulmar Pass, Tehri Garhwal; Jumnotri near the hot springs, Tehri Garhwal; Kidarkanta (10,000-11,000 ft.), Tehri Garhwal; Mussoorie range.
4.	*A. heterophyllum* Wall. (Perennial herb)	Atis, Patis	Root	Sub-alpine and alpine zones of the Himalayas of Kumaon and Tehri Garhwal from 6000-15,000 ft. Deoban (8000-9000 ft.), Jaunsar, Dehra Dun Dist.; Derali above Ganges Valley, Tehri Garhwal; Dudugadh under Srikanta (14,000-15,000 ft.), Tehri Garhwal; Milang glacier (12,500 ft.), Kumaon; Suraj Kund, Gori Valley, Kumaon.
5.	*Acorus calamus* Linn. (Perennial herb)	Sweet flag, Bach	Rhizome	In marshes or on river banks ascending to 6000 ft. in the Himalayas. Gohal (7000-8000 ft.), Tehri Garhwal; Kulni Valley (4000-5000 ft.), Tehri Garhwal; Manturgadh (4000 ft.), Tehri Garhwal; Mothronwala swamp (1900 ft.), Dehra Dun Dist.; Mussoorie; Tulsipur range, Gonda Dist.

No.	Botanical name of plant	Trade/Indian name	Part or parts used as crude drug	Areas and places where found wild in Uttar Pradesh
6.	*Adhatoda vasica* Nees (Shrub)	Vasaka, Arusa	Root, stem, bark, leaves, and flowers	Exceedingly common in the Dehra Dun Dist. and parts of Saharanpur Dist.; also found in Jaunsar in valleys up to 4000 ft. Dogari, Haldwani, Naini Tal Dist.; Kandhli village, Dehra Dun Dist.; Kathna-nadi, Kheri Dist.; Luckimpore; Morapati (1500 ft.), Lansdowne, Garhwal Dist.; Rajpur above Dehra Dun; Rambagh, Naini Tal; Saharanpur.
7.	*Aegle marmelos* Corr. (Small tree)	Bel, Bael	Root-bark, stem-bark, leaves, flowers, and fruits	Common in the Dehra Dun and Saharanpur forests: Banda; Chhakhata Range, Naini Tal Dist.; Dehra Dun forests; Dogari, Haldwani, Naini Tal Dist.; Dudhai, Bundelkhand; Lachiwala, Dehra Dun Dist.; Matipur, Bahraich Dist.; Raipur, Dehra Dun Dist.; Rishikesh, Dehra Dun Dist.; Saharanpur Siwaliks.
8.	*Angelica glauca* Edgw. (Herb)	Chorak, Chora	Root	Tehri Garhwal and Kumaon Himalayas from 6000-10,000 ft. Deota (7000-8000 ft.), Tehri Garhwal; Dhauli Valley (9000-10,000 ft.), Kumaon; Dombitiagadh (9000-11,000 ft.), Tehri Garhwal; Mandroolu forests under Bundarpunch (9000-10,000 ft.), Tehri Garhwal; Nili Valley in forest (11,000-12,000 ft.), Garhwal; Ralam Valley (9000-10,000 ft.), Kumaon; Sosa forests (9000-10,000 ft.), Kumaon.
9.	*Aristolochia indica* Linn. (Shrubby or herbaceous twiner)	Indian birthwort, Isramul	Root and rhizome	Plains and low hills. Lalitpur, Jhansi Dist.; Ranipur, Banda Division.
10.	*Artemisia maritima* Linn. (Perennial shrub)	Santonica, Murin, Seski	Flower-head, buds, and leaves	Kumaon Himalayas at 7000-11,000 ft. Girthi Valley (11,000 ft.), Garhwal; Panikhanda (10,000-11,000 ft.), Garhwal.

11.	*Asparagus racemosus* Willd. (Scandent undershrub)	Shatavri	Tubers	Throughout the plains ascending to 5000 ft. on the Himalayas. Agra near Jumna ravines; Bhira Range, Kheri Dist.; Binalgadh (5000 ft.), Jaunsar, Dehra Dun Dist.; Dharagadh (5000 ft.), Jaunsar, Dehra Dun Dist.; Dogari Range, Haldwani, Naini Tal Dist.; Dudhai, Bundelkhand; Gorha, Kheri Dist.; Gorakhpur; Jamnaguar, Dhara range, Garhwal; Narhewa, Gonda Dist.
12.	*Azadirachta indica* A. Juss. (Tree)	Neem	Leaves, bark and seeds	Fairly common along the foot of the Saharanpur Siwaliks and Dehra Dun forests. Banda; Bijnor forests; Chhakhata Range, Naini Tal Dist.; Dehra Dun forests; Etawah; Hardwar; Jaspur Range (2000 ft.), Naini Tal Dist.; Kasumri to Hardwar; Lalitpur, Jhansi Dist.; Mandholiya, Gorakhpur Dist.; Raipur, Dehra Dun; Saharanpur Siwaliks; Sakra, Gonda Dist.; Thana, Dehra Dun; Udepur range, Lansdowne, Garhwal Dist.
13.	*Bacopa monnieri* (Linn.) Pennell (Perennial herb)	Brahmi, Mandukparni	Entire plant	In damp, wet, and marshy areas ascending to 4000 ft. in the Himalayas. Banda by the riverside; Bhira, Kheri Dist.; Buksar, Garhwal; Kheri; Malari Range, Garhwal Division; Mansurwa, Gonda Dist.; Nakraunda, Dehra Dun; Pilibhit; Saharanpur.
14.	*Berberis aristata* DC. (Shrub)	Indian barberry, Rasaunt	Root and stem	Higher hills of Jaunsar at 7000-9000 ft. Bodyar, Jaunsar; Deoban, Jaunsar; Konain, Jaunsar; Lambatach, Jaunsar.
15.	*Boerhavia diffusa* Linn. (Perennial herb)	Punarnava	Whole plant	Throughout the plains ascending to 6000 ft. in the warm valleys of the Himalayas. Dehra Dun; Kheri Dist.; Gorakhpur Dist.; Pilibhit Dist.; below Mussoorie; Jaunpur; Kalona (3500 ft.), Kumaon.
16.	*Cannabis sativa* Linn. (Tall annual herb)	Indian hemp, Bhang	Leaves and flowering tops of female plants; also resin from female plants	Camping grounds and roadsides in Dehra Dun Dist., and in all camping grounds throughout the hills. Chaumoka, Gorakhpur Dist.; Dehra Dun; Hawalbagh, Kumaon; Janakpur, Gonda Dist.; Mahuf, Kheri Dist.; Mohrina, Kheri Dist.: Murthya, Bahraich Dist.; Naini Tal; Saharanpur.

No.	Botanical name of plant	Trade/Indian name	Part or parts used as crude drug	Areas and places where found wild in Uttar Pradesh
6.	*Adhatoda vasica* Nees (Shrub)	Vasaka, Arusa	Root, stem, bark, leaves, and flowers	Exceedingly common in the Dehra Dun Dist. and parts of Saharanpur Dist.; also found in Jaunsar in valleys up to 4000 ft. Dogari, Haldwani, Naini Tal Dist.; Kandhli village, Dehra Dun Dist.; Kathna-nadi, Kheri Dist.; Luckimpore; Morapati (1500 ft.), Lansdowne, Garhwal Dist.; Rajpur above Dehra Dun; Rambagh, Naini Tal; Saharanpur.
7.	*Aegle marmelos* Corr. (Small tree)	Bel, Bael	Root-bark, stem-bark, leaves, flowers, and fruits	Common in the Dehra Dun and Saharanpur forests: Banda; Chhakhata Range, Naini Tal Dist.; Dehra Dun forests; Dogari, Haldwani, Naini Tal Dist.; Dudhai, Bundelkhand; Lachiwala, Dehra Dun Dist.; Matipur, Bahraich Dist.; Raipur, Dehra Dun Dist.; Rishikesh, Dehra Dun Dist.; Saharanpur Siwaliks.
8.	*Angelica glauca* Edgw. (Herb)	Chorak, Chora	Root	Tehri Garhwal and Kumaon Himalayas from 6000-10,000 ft. Deota (7000-8000 ft.), Tehri Garhwal; Dhauli Valley (9000-10,000 ft.), Kumaon; Dombitiagadh (9000-11,000 ft.), Tehri Garhwal; Mandroolu forests under Bundarpunch (9000-10,000 ft.), Tehri Garhwal; Nili Valley in forest (11,000-12,000 ft.), Garhwal; Ralam Valley (9000-10,000 ft.), Kumaon; Sosa forests (9000-10,000 ft.), Kumaon.
9.	*Aristolochia indica* Linn. (Shrubby or herbaceous twiner)	Indian birthwort, Isramul	Root and rhizome	Plains and low hills. Lalitpur, Jhansi Dist.; Ranipur, Banda Division.
10.	*Artemisia maritima* Linn. (Perennial shrub)	Santonica, Murin, Seski	Flower-head, buds, and leaves	Kumaon Himalayas at 7000-11,000 ft. Girthi Valley (11,000 ft.), Garhwal; Panikhanda (10,000-11,000 ft.), Garhwal.
11.	*Asparagus racemosus* Willd. (Scandent undershrub)	Shatavri	Tubers	Throughout the plains ascending to 5000 ft. on the Himalayas. Agra near Jumna ravines; Bhira Range, Kheri Dist.; Binalgadh (5000 ft.), Jaunsar, Dehra Dun Dist.; Dharagadh (5000 ft.), Jaunsar, Dehra Dun Dist.; Dogari Range, Haldwani, Naini Tal Dist.; Dudhai, Bundelkhand; Gorha, Kheri Dist.; Gorakhpur; Jamnaguar, Dhara range, Garhwal; Narhewa, Gonda Dist.
12.	*Azadirachta indica* A. Juss. (Tree)	Neem	Leaves, bark and seeds	Fairly common along the foot of the Saharanpur Siwaliks and Dehra Dun forests. Banda; Bijnor forests; Chhakhata Range, Naini Tal Dist.; Dehra Dun forests; Etawah; Hardwar; Jaspur Range (2000 ft.), Naini Tal Dist.; Kasumri to Hardwar; Lalitpur, Jhansi Dist.; Mandholiya, Gorakhpur Dist.; Raipur, Dehra Dun; Saharanpur Siwaliks; Sakra, Gonda Dist.; Thana, Dehra Dun; Udepur range, Lansdowne, Garhwal Dist.
13.	*Bacopa monnieri* (Linn.) Pennell (Perennial herb)	Brahmi, Mandukparni	Entire plant	In damp, wet, and marshy areas ascending to 4000 ft. in the Himalayas. Banda by the riverside; Bhira, Kheri Dist.; Buksar, Garhwal; Kheri; Malari Range, Garhwal Division; Mansurwa, Gonda Dist.; Nakraunda, Dehra Dun; Pilibhit; Saharanpur.
14.	*Berberis aristata* DC. (Shrub)	Indian barberry, Rasaunt	Root and stem	Higher hills of Jaunsar at 7000-9000 ft. Bodyar, Jaunsar; Deoban, Jaunsar; Konain, Jaunsar; Lambatach, Jaunsar.
15.	*Boerhavia diffusa* Linn. (Perennial herb)	Punarnava	Whole plant	Throughout the plains ascending to 6000 ft. in the warm valleys of the Himalayas. Dehra Dun; Kheri Dist.; Gorakhpur Dist.; Pilibhit Dist.; below Mussoorie; Jaunpur; Kalona (3500 ft.), Kumaon.
16.	*Cannabis sativa* Linn. (Tall annual herb)	Indian hemp, Bhang	Leaves and flowering tops of female plants; also resin from female plants	Camping grounds and roadsides in Dehra Dun Dist., and in all camping grounds throughout the hills. Chaumoka, Gorakhpur Dist.; Dehra Dun; Hawalbagh, Kumaon; Janakpur, Gonda Dist.; Mahuf, Kheri Dist.; Mohrina, Kheri Dist.: Murthya, Bahraich Dist.; Naini Tal; Saharanpur.

No.	Botanical name of plant	Trade/Indian name	Part or parts used as crude drug	Areas and places where found wild in Uttar Pradesh
17.	*Cassia fistula* Linn. (Medium-sized tree)	Amaltas	Fruit (Fruit pulp)	Abundant throughout the Dehra Dun and Saharanpur forests; also found in low valleys up to 4000 ft. in Jaunsar and Tehri Garhwal. Adnala Range (2000 ft.), Garhwal Dist.; Amlawa Valley up to Saia, Jaunsar; Chauk, Gorakhpur Dist.; Chhakhata Range, Naini Tal Dist.; Dehra Dun forests; Dogari, Haldwani, Naini Tal Dist.; Jaunsar valleys; Jaspur Range (2000 ft.), Naini Tal Dist.; Kaladhungi, Naini Tal Dist.; Kalsi, Dehra Dun Dist.; Kumia, Haldwani, Naini Tal Dist.; Lansdowne, Garhwal Dist.; Mora (3500 ft.), Naini Tal Dist.; Naini Tal; Phandowala, Dehra Dun Dist.; Paniganj, Gonda Dist.; Saharanpur forests.
18.	*Centella asiatica* (Linn.) Urban (Perennial herb)	Brahmi, Manduki	Entire plant	In marshy places and wet ground ascending to 6000 ft. in the Himalayas. Agra; Dehra Dun; Ganughat, Gorakhpur Dist.; Lobah (5000-6000 ft.), Garhwal; Mussoorie below; Sansradhara, Dehra Dun.
19.	*Cinnamomum tamala* Nees & Eberm. (Moderate-sized tree)	Tejput	Bark and leaves	Abundant in the outer Himalayan ranges up to 7000 ft.; occurs sporadically in damp ravines in Jaunsar and Tehri Garhwal, up to 6000 ft.; very common in the Mautargadh. Bagur-nala, Tehri Garhwal; Chatragadh, Jaunsar; Dhauligadh (4000 ft.), Jaunsar; Kutnoor Tishi, Garhwal; Malkot, Dehra Dun Dist.; Mautargadh, Jaunsar; Mola (3500 ft.), Naini Tal Dist.; Morargadh (4000 ft.), Tons Valley, Tehri Garhwal; Surjoo Valley, Kumaon; Thadiar Valley, Tehri Garhwal; Tons Valley (4000 ft.), Tehri Garhwal.
20.	*Citrullus colocynthis* Schrad. (Perennial herb)	Colocynth, Kaur-tumma	Fruit	Sandy tracts in the plains. Saharanpur.
21.	*Datura stramonium* Linn. (Bushy annual herb)	Dhatura	Leaves and seeds	Sub-Himalayan tracts. Almora; Naini Tal; Ranikhet, Almora Dist.

22.	*Dryopteris schimperiana* (Hochst.) C. Chr. (Perennial fern)	Male fern	Rhizome and frond-bases	Himalayas at 6000-9000 ft.; common in Mussoorie hills. Mussoorie (7000 ft.).
23.	*Ephedra gerardiana* Wall. (Low rigid tufted shrub)	Ephedra, Toot-gantha, Butshur	Stem	Drier regions of the temperate and alpine Himalayas at 7000-14,000 ft. Badrinath (9150-12,000 ft.), Garhwal Dist.; Chalek (10,050-10,950 ft.), Almora Dist.; Deoban-Mundali road (9000 ft.), Jaunsar; Deoban Ridge, Jaunsar; Dhauli Valley on rocks (10,050-10,950 ft.), Kumaon; Gangotri (12,000-13,000 ft.), Tehri Garhwal; Giddikhad (8000-9000 ft.), Jaunsar; below Kharamba Peak, Dehra Dun Dist.; Kuthi Valley (11,000-12,000 ft.), Kumaon; Malari Valley (12,000 ft.), Garhwal; Milam (9000-16,000 ft.), Gori Valley, Almora Dist.; Nili Valley (14,000-15,000 ft.), Garhwal; Nipchang Valley in Darma (11,000-13,000 ft.), Kumaon; Pindari (9000-16,000 ft.), Almora Dist.; Suki, Bhagirthi Ganges, Garhwal; Tuktung, Dhauli Valley (10,050-10,950 ft.), Kumaon.
24.	*Gentiana kurroo* Roy e (Perennial herb)	Karu, Kamal-phul, Nilkant	Root and rhizome	Himalayas at 5000-11,000 ft. Anvjadh (5500 ft.), Mussoorie; Chakrata (7500 ft.), Dehra Dun Dist.; Gangotri, Tehri Garhwal; Jangla, Tehri Garhwal; Kanasar-Konain road (7500 ft.), Jaunsar; Mussoorie.
25.	*Hemidesmus indicus* R. Br. (Twining or prostrate shrub)	Indian sarsaparilla, Anantamul	Root	Upper Gangetic Plain. Bahraich; Bundelkhand; Gonda; Gorakhpur forests; Jagpur, Gorakhpur Dist.; Sehelwa, Gonda Dist.
26.	*Holarrhena antidysenterica* Wall. (Small tree)	Kurchi	Bark	Abundant in Dehra Dun and Saharanpur forests, on the Siwalik Range and throughout the sub-Himalayan tract eastwards to Gorakhpur; also in Bundelkhand and in valleys up to 4000 ft. in Jaunsar and Tehri Garhwal. Badrinath, Garhwal; Bankatwa, Bahraich Dist.; Bargad, Pilibhit Dist.; Bhira, Kheri Dist.; Chauk, Gorakhpur Dist.; Chela Sarda, Haldwani, Naini Tal Dist.; Dehra Dun; Dogari (2000 ft.), Haldwani, Naini Tal Dist.; Halaguddi block, Adnala range, Garhwal Dist.; Janakpur, Gonda Dist.; Kaladhungi, Naini Tal Dist.; Kalsi, Dehra Dun Dist.; Kheri; Kuluga, Haldwani, Naini Tal Dist.; Lansdowne outer forests (up to 1900 ft.), Garhwal Dist.; Lobah, Garhwal Dist.; Pindarpur reserve, N. Garhwal; Raipur road, Dehra Dun; Raipur in hills above (3000 ft.), Dehra Dun Dist.; Ramgarh, Gorakhpur Dist.; Taria block, Adnala range, Garhwal Dist.

No.	Botanical name of plant	Trade/Indian name	Part or parts used as crude drug	Areas and places where found wild in Uttar Pradesh
17.	*Cassia fistula* Linn. (Medium-sized tree)	Amaltas	Fruit (Fruit pulp)	Abundant throughout the Dehra Dun and Saharanpur forests; also found in low valleys up to 4000 ft. in Jaunsar and Tehri Garhwal. Adnala Range (2000 ft.), Garhwal Dist.; Amlawa Valley up to Saia, Jaunsar; Chauk, Gorakhpur Dist.; Chhakhata Range, Naini Tal Dist.; Dehra Dun forests; Dogari, Haldwani, Naini Tal Dist.; Jaunsar valleys; Jaspur Range (2000 ft.), Naini Tal Dist.; Kaladhungi, Naini Tal Dist.; Kalsi, Dehra Dun Dist.; Kumia, Haldwani, Naini Tal Dist.; Lansdowne, Garhwal Dist.; Mora (3500 ft.), Naini Tal Dist.; Naini Tal; Phandowala, Dehra Dun Dist.; Paniganj, Gonda Dist.; Saharanpur forests.
18.	*Centella asiatica* (Linn.) Urban (Perennial herb)	Brahmi, Manduki	Entire plant	In marshy places and wet ground ascending to 6000 ft. in the Himalayas. Agra; Dehra Dun; Ganughat, Gorakhpur Dist.; Lobah (5000-6000 ft.), Garhwal; Mussoorie below; Sansradhara, Dehra Dun.
19.	*Cinnamomum tamala* Nees & Eberm. (Moderate-sized tree)	Tejput	Bark and leaves	Abundant in the outer Himalayan ranges up to 7000 ft.; occurs sporadically in damp ravines in Jaunsar and Tehri Garhwal, up to 6000 ft.; very common in the Mautargadh. Bagur-nala, Tehri Garhwal; Chatragadh, Jaunsar; Dhauligadh (4000 ft.), Jaunsar; Kutnoor Tishi, Garhwal; Malkot, Dehra Dun Dist.; Mautargadh, Jaunsar; Mola (3500 ft.), Naini Tal Dist.; Morargadh (4000 ft.), Tons Valley, Tehri Garhwal; Surjoo Valley, Kumaon; Thadiar Valley, Tehri Garhwal; Tons Valley (4000 ft.), Tehri Garhwal.
20.	*Citrullus colocynthis* Schrad. (Perennial herb)	Colocynth, Kaur-tumma	Fruit	Sandy tracts in the plains. Saharanpur.
21.	*Datura stramonium* Linn. (Bushy annual herb)	Dhatura	Leaves and seeds	Sub-Himalayan tracts. Almora; Naini Tal; Ranikhet, Almora Dist.
22.	*Dryopteris schimperiana* (Hochst.) C. Chr. (Perennial fern)	Male fern	Rhizome and frond-bases	Himalayas at 6000-9000 ft.; common in Mussoorie hills. Mussoorie (7000 ft.).
23.	*Ephedra gerardiana* Wall. (Low rigid tufted shrub)	Ephedra, Toot-gantha, Butshur	Stem	Drier regions of the temperate and alpine Himalayas at 7000-14,000 ft. Badrinath (9150-12,000 ft.), Garhwal Dist.; Chalek (10,050-10,950 ft.), Almora Dist.; Deoban-Mundali road (9000 ft.), Jaunsar; Deoban Ridge, Jaunsar; Dhauli Valley on rocks (10,050-10,950 ft.), Kumaon; Gangotri (12,000-13,000 ft.), Tehri Garhwal; Giddikhad (8000-9000 ft.), Jaunsar; below Kharamba Peak, Dehra Dun Dist.; Kuthi Valley (11,000-12,000 ft.), Kumaon; Malari Valley (12,000 ft.), Garhwal; Milam (9000-16,000 ft.), Gori Valley, Almora Dist.; Nili Valley (14,000-15,000 ft.), Garhwal; Nipchang Valley in Darma (11,000-13,000 ft.), Kumaon; Pindari (9000-16,000 ft.), Almora Dist.; Suki, Bhagirthi Ganges, Garhwal; Tuktung, Dhauli Valley (10,050-10,950 ft.), Kumaon.
24.	*Gentiana kurroo* Roy e (Perennial herb)	Karu, Kamal-phul, Nilkant	Root and rhizome	Himalayas at 5000-11,000 ft. Anvjadh (5500 ft.), Mussoorie; Chakrata (7500 ft.), Dehra Dun Dist.; Gangotri, Tehri Garhwal; Jangla, Tehri Garhwal; Kanasar-Konain road (7500 ft.), Jaunsar; Mussoorie.
25.	*Hemidesmus indicus* R. Br. (Twining or prostrate shrub)	Indian sarsaparil-la, Anantamul	Root	Upper Gangetic Plain. Bahraich; Bundelkhand; Gonda; Gorakhpur forests; Jagpur, Gorakhpur Dist.; Sehelwa, Gonda Dist.
26.	*Holarrhena antidysenterica* Wall. (Small tree)	Kurchi	Bark	Abundant in Dehra Dun and Saharanpur forests, on the Siwalik Range and throughout the sub-Himalayan tract eastwards to Gorakhpur; also in Bundelkhand and in valleys up to 4000 ft. in Jaunsar and Tehri Garhwal. Badrinath, Garhwal; Bankatwa, Bahraich Dist.; Bargad, Pilibhit Dist.; Bhira, Kheri Dist.; Chauk, Gorakhpur Dist.; Chela Sarda, Haldwani, Naini Tal Dist.; Dehra Dun; Dogari (2000 ft.), Haldwani, Naini Tal Dist.; Halaguddi block, Adnala range, Garhwal Dist.; Janakpur, Gonda Dist.; Kaladhungi, Naini Tal Dist.; Kalsi, Dehra Dun Dist.; Kheri; Kuluga, Haldwani, Naini Tal Dist.; Lansdowne outer forests (up to 1900 ft.), Garhwal Dist.; Lobah, Garhwal Dist.; Pindarpur reserve, N. Garhwal; Raipur road, Dehra Dun; Raipur in hills above (3000 ft.), Dehra Dun Dist.; Ramgarh, Gorakhpur Dist.; Taria block, Adnala range, Garhwal Dist.

No.	Botanical name of plant	Trade/Indian name	Part or parts used as crude drug	Areas and places where found wild in Uttar Pradesh
27.	*Ipomoea hederacea* (Linn.) Jacq. (Annual climber)	Kaladana	Seeds	Common in the Dehra Dun Dist. ; ascending to 6000 ft. in the Himalayas. Aglar Valley near Mussoorie ; Chakrata, Dehra Dun Dist.; Dehra Dun ; Dubhawala, Dehra Dun ; Kaulagarh, Dehra Dun ; Naini Tal ; Saharanpur.
28.	*Mentha piperita* Linn. (Perennial herb)	Peppermint	Sub-aerial parts	Run wild in the Dehra Dun Dist. and some other places. Dehra Dun New Forest along water courses ; Saharanpur.
29.	*Nardostachys jatamansi* DC. (Perennial herb)	Jatamansi, Balchar, Bhutjatta	Rhizome and root	Alpine Himalayas at 11,000-15,000 ft. in Kumaon and Tehri Garhwal. Badrinath, Garhwal ; Chipla, E. Kumaon ; Damodar Valley in rocks (14,000-15,000 ft.), Tehri Garhwal; Dudugadh in rocks (14,000-15,000 ft.), under Srikanta, Tehri Garhwal ; Gangotri (13,000-14,000 ft.), Tehri Garhwal; Kuthi Yankti Valley, Kumaon; Nili Valley (13,000-14,000 ft.), Tehri Garhwal; Palang-gadh, Byans (11,000-12,000 ft.), Almora Dist.; Pangachuli (13,000 ft.), Garhwal ; Pindarpur reserve, N. Garhwal ; Ralam Valley (14,000-15,000 ft.) Kumaon.
30.	*Picrasma quassioides* Benn. (Large shrub)	Bharangi, Quassia	Wood	Outer Himalayas above Rajpur and in shady ravines in Jaunsar and Tehri Garhwal at 5000-8000 ft. Bamnaigadh, Jaunsar ; Bamsu reserve (5000-6000 ft.), Tehri Garhwal ; Chakrata (7000 ft.), Dehra Dun Dist. ; Chansilgadh (6000-7000 ft.), Tehri Garhwal ; Dakara (6000-7000 ft.), Tehri Garhwal ; Deoban, Jaunsar ; Deota (7000-8000 ft.), Tehri Garhwal ; Joshimath (6400 ft.), Garhwal ; Kulni, Tehri Garhwal ; Mundali, (5000 ft.), Dehra Dun Dist. ; Mussoorie ; Nakraunda, Dehra Dun ; Oura (6000 ft.), Tehri Garhwal ; Ramni (5500 ft.), Garhwal ; Rupin on the banks, Tehri Garhwal ; Tons Valley, (6000 ft.) Tehri Garhwal.

31.	*Picrorhiza kurroa* Royle ex Benth. (Perennial herb)	Karu	Rhizome	Common in the alpine Himalayas of Garhwal at 9000-15,000 ft. Badrinath (10,000-12,000 ft.), Garhwal Dist.; Jamara camping ground in ravines (13,000-14,000 ft.), Damodar Valley, Tehri Garhwal; Kidarkanta (10,000-11,000 ft.), Tehri Garhwal; Kuari Pass (11,000-12,000 ft,), Garhwal; Mussoorie; Palanggadh, Byans, Almora Dist.; Phulaldaru, Nili Valley, (12,000-13,000 ft.), Garhwal; Ramni (11,500 ft.), Garhwal; Ralam Valley, Kumaon.
32.	*Piper longum* Linn. (Slender undershrub)	Piplamul	Root and fruit	Shady localities in the Dehra Dun Dist. and lower hills. Lachiwala, Dehra Dun Dist.; Lakhond, Dehra Dun Dist.; Nisanghara range, Bahraich Division.
33.	*Podophyllum hexandrum* Royle (Perennial herb)	Bankakri, Papra	Root and rhizome	Himalayan ranges between 7000-14,000 ft.; common in shady places above 7000 ft. in Jaunsar and Tehri Garhwal. Bodyar (7800 ft.), Jaunsar, Dehra Dun Dist.; Dasoli, Garhwal Dist.; Deoban (9000 ft.), Jaunsar, Dehra Dun Dist.; Dudugadh (14,000-15,000 ft.), Tehri Garhwal; Jamnotri, Tehri Garhwal; Kanjatra (8500 ft.), Jaunsar, Dehra Dun Dist.; Kidarkanta (10,000-11,000 ft.), Tehri, Garhwal; Konain, Jaunsar, Dehra Dun Dist.; Kuthi Yankti Valley (12,000-13,000 ft.), Almora Dist.; Mundali (7500 ft.), Jaunsar, Dehra Dun Dist.; Pindari glacier, Almora Dist.; Rudugaria Gadh (13,000-14,000 ft.), Tehri Garhwal.
34.	*Polygala chinensis* Linn. (Annual herb)	Indian senega, Meradu	Root	Plains ascending to 5000 ft. in the hills. Agra; Allahabad; Almora (4000-5000 ft.); Banda; Dehra Dun; Dharasu to Dunda (3000-4000 ft.), Ganges Valley, Tehri Garhwal; Hamirpur; Jalaun; Jhansi; Kyrna (4000-5000 ft.), Kumaon; Moradabad; Nandgaon (5000 ft.), Jumna Valley, Tehri Garhwal.
35.	*Psoralea corylifolia* Linn. (Erect annual herb)	Babchi, Vakuchi	Seeds	Throughout Oudh and Bundelkhand and in Dehra Dun. Bahraich; Balrampur, Gonda Dist.; Barabanki, Lucknow Dist.; Bundelkhand; Dehra Dun.

No.	Botanical name of plant	Trade/Indian name	Part or parts used as crude drug	Areas and places where found wild in Uttar Pradesh
27.	*Ipomoea hederacea* (Linn.) Jacq. (Annual climber)	Kaladana	Seeds	Common in the Dehra Dun Dist.; ascending to 6000 ft. in the Himalayas. Aglar Valley near Mussoorie; Chakrata, Dehra Dun Dist.; Dehra Dun; Dubhawala, Dehra Dun; Kaulagarh, Dehra Dun; Naini Tal; Saharanpur.
28.	*Mentha piperita* Linn. (Perennial herb)	Peppermint	Sub-aerial parts	Run wild in the Dehra Dun Dist. and some other places. Dehra Dun New Forest along water courses; Saharanpur.
29.	*Nardostachys jatamansi* DC. (Perennial herb)	Jatamansi, Balchar, Bhutjatta	Rhizome and root	Alpine Himalayas at 11,000-15,000 ft. in Kumaon and Tehri Garhwal. Badrinath, Garhwal; Chipla, E. Kumaon; Damodar Valley in rocks (14,000-15,000 ft.), Tehri Garhwal; Dudugadh in rocks (14,000-15,000 ft.), under Srikanta, Tehri Garhwal; Gangotri (13,000-14,000 ft.), Tehri Garhwal; Kuthi Yankti Valley, Kumaon; Nili Valley (13,000-14,000 ft.), Tehri Garhwal; Palanggadh, Byans (11,000-12,000 ft.), Almora Dist.; Pangachuli (13,000 ft.), Garhwal; Pindarpur reserve, N. Garhwal; Ralam Valley (14,000-15,000 ft.) Kumaon.
30.	*Picrasma quassioides* Benn. (Large shrub)	Bharangi, Quassia	Wood	Outer Himalayas above Rajpur and in shady ravines in Jaunsar and Tehri Garhwal at 5000-8000 ft. Bamnaigadh, Jaunsar; Bamsu reserve (5000-6000 ft.), Tehri Garhwal; Chakrata (7000 ft.), Dehra Dun Dist.; Chansilgadh (6000-7000 ft.), Tehri Garhwal; Dakara (6000-7000 ft.), Tehri Garhwal; Deoban, Jaunsar; Deota (7000-8000 ft.), Tehri Garhwal; Joshimath (6400 ft.), Garhwal; Kulni, Tehri Garhwal; Mundali, (5000 ft.), Dehra Dun Dist.; Mussoorie; Nakraunda, Dehra Dun; Oura (6000 ft.), Tehri Garhwal; Ramni (5500 ft.), Garhwal; Rupin on the banks, Tehri Garhwal; Tons Valley, (6000 ft.) Tehri Garhwal.
31.	*Picrorhiza kurroa* Royle ex Benth. (Perennial herb)	Karu	Rhizome	Common in the alpine Himalayas of Garhwal at 9000-15,000 ft. Badrinath (10,000-12,000 ft.), Garhwal Dist.; Jamara camping ground in ravines (13,000-14,000 ft.), Damodar Valley, Tehri Garhwal; Kidarkanta (10,000-11,000 ft.), Tehri Garhwal; Kuari Pass (11,000-12,000 ft.), Garhwal; Mussoorie; Palanggadh, Byans, Almora Dist.; Phulaldaru, Nili Valley, (12,000-13,000 ft.), Garhwal; Ramni (11,500 ft.), Garhwal; Ralam Valley, Kumaon.
32.	*Piper longum* Linn. (Slender undershrub)	Piplamul	Root and fruit	Shady localities in the Dehra Dun Dist. and lower hills. Lachiwala, Dehra Dun Dist.; Lakhond, Dehra Dun Dist.; Nisanghara range, Bahraich Division.
33.	*Podophyllum hexandrum* Royle (Perennial herb)	Bankakri, Papra	Root and rhizome	Himalayan ranges between 7000-14,000 ft.; common in shady places above 7000 ft. in Jaunsar and Tehri Garhwal. Bodyar (7800 ft.), Jaunsar, Dehra Dun Dist.; Dasoli, Garhwal Dist.; Deoban (9000 ft.), Jaunsar, Dehra Dun Dist.; Dudugadh (14,000-15,000 ft.), Tehri Garhwal; Jamnotri, Tehri Garhwal; Kanjatra (8500 ft.), Jaunsar, Dehra Dun Dist.; Kidarkanta (10,000-11,000 ft.), Tehri, Garhwal; Konain, Jaunsar, Dehra Dun Dist.; Kuthi Yankti Valley (12,000-13,000 ft.), Almora Dist.; Mundali (7500 ft.), Jaunsar, Dehra Dun Dist.; Pindari glacier, Almora Dist.; Rudugaria Gadh (13,000-14,000 ft.), Tehri Garhwal.
34.	*Polygala chinensis* Linn. (Annual herb)	Indian senega, Meradu	Root	Plains ascending to 5000 ft. in the hills. Agra; Allahabad; Almora (4000-5000 ft.); Banda; Dehra Dun; Dharasu to Dunda (3000-4000 ft.), Ganges Valley, Tehri Garhwal; Hamirpur; Jalaun; Jhansi; Kyrna (4000-5000 ft.), Kumaon; Moradabad; Nandgaon (5000 ft.), Jumna Valley, Tehri Garhwal.
35.	*Psoralea corylifolia* Linn. (Erect annual herb)	Babchi, Vakuchi	Seeds	Throughout Oudh and Bundelkhand and in Dehra Dun. Bahraich; Balrampur, Gonda Dist.; Barabanki, Lucknow Dist.; Bundelkhand; Dehra Dun.

No.	Botanical name of plant	Trade/Indian name	Part or parts used as crude drug	Areas and places where found wild in Uttar Pradesh
36.	*Pterocarpus marsupium* Roxb. (Tall or medium-sized tree)	Bijasal	Wood and gum	Forests of Pilibhit, N. Oudh, Gorakhpur, Bundelkhand and Kumaon Terai. Bahraich; Bundelkhand; Dogari range, Haldwani, Naini Tal Dist.; Gonda; Gorakhpur forests; Kakralisarda, Haldwani, Naini Tal Dist.; Kumaon Terai; Naini Tal; Pilibhit forests.
37.	*Rauwolfia serpentina* Benth. ex Kurz (Small shrub)	Sarpagandha, Root chandrika, Harkai	Root	Sub-Himalayan tracts. Chauk, Gorakhpur; Lachiwala, Dehra Dun Dist.; Bahraich; Mustafabad, Pilibhit Dist.; Bargad Chauki, Pilibhit Division; Kakardari, Bahraich Dist.; Dudhua, Kheri Dist.
38.	*Rheum emodi* Wall. (Perennial herb)	Rhubarb, Revandchini	Rhizome	Himalayas at 11,000-12,000 ft.; Tehri Garhwal. Gangotri (11,000-12,000 ft.), Tehri Garhwal; Harki Dun (11,000 ft.), Dehra Dun Dist.: Melan glacier (12,500 ft.), Kumaon; Nili Valley (11,000-12,000 ft.), Tehri Garhwal; Suki, Ganges Valley (9000-10,000 ft.), Tehri Garhwal.
39.	*R. webbianum* Royle (Perennial herb)	Rhubarb, Revandchini	Rhizome	Alpine Himalayas at 10,000-14,000 ft. Kuthi Yankti Valley, Byans (12,000-13,000 ft.), Almora Dist.; Nabbi Valley, Byans (12,000-13,000 ft.), Almora Dist.
40.	*Swertia chirata* Buch.-Ham. (Annual herb)	Chirata	Entire plant	Temperate zone of the Himalayas at 5000-10,000 ft. Asno (8000 ft.), Tehri Garhwal; Jabbankhet, Mussoorie; Jerrapani near Mussoorie; Khatawa (6000 ft.), Jaunsar; Konain (8000 ft.), Jaunsar; Mussoorie; Mussoorie road to Kemti Falls; Naini Tal (8000 ft.).
41.	*Terminalia chebula* Retz. (Large tree)	Myrobalan Harar, Harir	Fruit	Forests of Dehra Dun and Saharanpur, Rohilkhand, N. Oudh and Bundelkhand. Adnala Range (2900 ft.), Garhwal Dist.; Amlawa Valley, Jaunsar; Bahraich forests; Chhakhata Range, Naini Tal Dist.; Dehra Dun forests; Dharasu (4000-5000 ft.), Ganges Valley, Tehri Garhwal; Dudhwa, Kheri Dist.; Gonda; Jaspur Range, Naini Tal Dist.; Kheri; Kilpura, Dogari, Haldwani, Naini Tal Dist.; Lachiwala, Dehra Dun Dist.; Lambi-Rau on the sides, Saharanpur Siwaliks; Mangoli, Naini Tal Dist.; Marori, Pilibhit Dist.; Nagsidh forests, Dehra Dun; Ranee Bagh roadsides,

				Kumaon : Saharanpur forests; Sar (3500 ft.), Garhwal; Sungarhe Gonda Dist.; Thano forests, Dehra Dun Dist.; Timli Pass, Saharanpur Siwaliks; Tons Valley, Jaunsar.
42.	*Urginea indica* Kunth (Perennial herb)	Indian squill, Jangli-piaaj	Bulbs	Siwalik Range, Sub-Himalayan tract of Pilibhit and N. Oudh, Tons Valley and Kumaon. Almora outer hills, Kumaon; Dhara Range, Thadiar Valley, Garhwal; Jamnaguar, Dhara Range, Garhwal; Moragadh (3000-4000 ft.), Tons Valley, Tehri Garhwal; Pilibhit, Sub-Himalayan tract; Pindar Valley (4500 ft.), Garhwal; Pipra, Gonda Dist.; Saharanpur Siwaliks; Sendra, Tons Valley, Tehri Garhwal; Thadiar Valley (3000-4000 ft.), Tehri Garhwal; Tons Valley (3000-4000 ft.), Tehri Garhwal.
43.	*Valeriana wallichii* DC. (Perennial herb)	Valerian, Mushkbala	Root and rhizome	Temperate Himalayas at 4000-12,000 ft. in Tehri Garhwal, Kumaon and Jaunsar. Deoban (8000-9000 ft.), Jaunsar; Deota forests (8000-9000 ft.), Tehri Garhwal; Jamara camping ground (11,000 ft.), Damodar Valley, Tehri Garhwal; Khansar Patt, Garhwal; Kharamba above Mumdali, Dehra Dun Dist.; Kidarkanta (10,000-11,000 ft.), Tehri Garhwal; Kuari Pass (12,000-13,000 ft.), Garhwal; Kuthi Yankti Valley, Almora Dist.; Landour, Mussoorie; Mundalin forests (8000-9000 ft.), Dehra Dun Dist.; Mundali (8500 ft.), Jaunsar; Mussoorie; Mussoorie road to Kemti Falls; Naini Tal; Palanggadh, Byans, Almora Dist.; Pheti (4000-5000 ft.), Tehri Garhwal; Pindari glacier, Kumaon; Phulaldaru forests (11,000-12,000 ft.), Tehri Garhwal; Ramni (7000-8000 ft.), Garhwal; Ranikhet (5000-6000 ft.), Almora Dist.
44.	*Viola serpens* Wall. (Small herb)	Banafsha	Flowers and also entire plant	A small herb common in the woods above 7000 ft. in the hilly districts. China Thall (7000 ft.), Naini Tal; Deoban (7000-8000 ft.), Jaunsar; Jangla River banks, Ganges Valley (8000-9000 ft.), Tehri Garhwal; Kerwa, Jaunsar; Kidarkanta (10,000-11,000 ft.), Tehri Garhwal; Kinani Pani, Jaunsar; Kinani Pani to Jako Pass (8000-9000 ft.), Jaunsar; Konain (7300 ft.), Jaunsar; Mussoorie in woods above; Naini Tal; Suki to Jhala, Ganges Valley (8000-9000 ft.), Tehri Garhwal.
45.	*Withania somnifera* Dunal (Erect under-shrub)	Asgand	Root	Common in dry situations throughout the State. Allahabad; Banda; Dehra Dun; Kheri; Lucknow; Mala nadi, Pilibhit Dist.; Pilibhit; Raipur (2500 ft.), Dehra Dun Dist.

No.	Botanical name of plant	Trade/Indian name	Part or parts used as crude drug	Areas and places where found wild in Uttar Pradesh
36.	*Pterocarpus marsupium* Roxb. (Tall or medium-sized tree)	Bijasal	Wood and gum	Forests of Pilibhit, N. Oudh, Gorakhpur, Bundelkhand and Kumaon Terai. Bahraich; Bundelkhand; Dogari range, Haldwani, Naini Tal Dist.; Gonda; Gorakhpur forests; Kakralisarda, Haldwani, Naini Tal Dist.; Kumaon Terai; Naini Tal; Pilibhit forests.
37.	*Rauwolfia serpentina* Benth. ex Kurz (Small shrub)	Sarpagandha, Root chandrika, Harkai	Root	Sub-Himalayan tracts. Chauk, Gorakhpur; Lachiwala, Dehra Dun Dist.; Bahraich; Mustafabad, Pilibhit Dist.; Bargad Chauki, Pilibhit Division; Kakardari, Bahraich Dist.; Dudhua, Kheri Dist.
38.	*Rheum emodi* Wall. (Perennial herb)	Rhubarb, Revandchini	Rhizome	Himalayas at 11,000-12,000 ft.; Tehri Garhwal. Gangotri (11,000-12,000 ft.), Tehri Garhwal; Harki Dun (11,000 ft.), Dehra Dun Dist.: Melan glacier (12,500 ft.), Kumaon; Nili Valley (11,000-12,000 ft.), Tehri Garhwal; Suki, Ganges Valley (9000-10,000 ft.), Tehri Garhwal.
39.	*R. webbianum* Royle (Perennial herb)	Rhubarb, Revandchini	Rhizome	Alpine Himalayas at 10,000-14,000 ft. Kuthi Yankti Valley, Byans (12,000-13,000 ft.), Almora Dist.; Nabbi Valley, Byans (12,000-13,000 ft.), Almora Dist.
40.	*Swertia chirata* Buch.-Ham. (Annual herb)	Chirata	Entire plant	Temperate zone of the Himalayas at 5000-10,000 ft. Asno (8000 ft.), Tehri Garhwal; Jabbankhet, Mussoorie; Jerrapani near Mussoorie; Khatawa (6000 ft.), Jaunsar; Konain (8000 ft.), Jaunsar; Mussoorie; Mussoorie road to Kemti Falls: Naini Tal (8000 ft.).
41.	*Terminalia chebula* Retz. (Large tree)	Myrobalan Harar, Harir	Fruit	Forests of Dehra Dun and Saharanpur, Rohilkhand, N. Oudh and Bundelkhand. Adnala Range (2900 ft.), Garhwal Dist.; Amlawa Valley, Jaunsar; Bahraich forests; Chhakhata Range, Naini Tal Dist.; Dehra Dun forests; Dharasu (4000-5000 ft.), Ganges Valley, Tehri Garhwal; Dudhwa, Kheri Dist.; Gonda; Jaspur Range, Naini Tal Dist.; Kheri; Kilpura, Dogari, Haldwani, Naini Tal Dist.; Lachiwala, Dehra Dun Dist.; Lambi-Rau on the sides, Saharanpur Siwaliks; Mangoli, Naini Tal Dist.; Marori, Pilibhit Dist.; Nagsidh forests, Dehra Dun; Ranee Bagh roadsides, Kumaon: Saharanpur forests; Sar (3500 ft.), Garhwal; Sungarhe Gonda Dist.; Thano forests, Dehra Dun Dist.; Timli Pass, Saharanpur Siwaliks; Tons Valley, Jaunsar.
42.	*Urginea indica* Kunth (Perennial herb)	Indian squill, Jangli-piaaj	Bulbs	Siwalik Range, Sub-Himalayan tract of Pilibhit and N. Oudh, Tons Valley and Kumaon. Almora outer hills, Kumaon; Dhara Range, Thadiar Valley, Garhwal; Jamnaguar, Dhara Range, Garhwal; Moragadh (3000-4000 ft.), Tons Valley, Tehri Garhwal; Pilibhit, Sub-Himalayan tract; Pindar Valley (4500 ft.), Garhwal; Pipra, Gonda Dist.; Saharanpur Siwaliks; Sendra, Tons Valley, Tehri Garhwal; Thadiar Valley (3000-4000 ft.), Tehri Garhwal; Tons Valley (3000-4000 ft.), Tehri Garhwal.
43.	*Valeriana wallichii* DC. (Perennial herb)	Valerian, Mushkbala	Root and rhizome	Temperate Himalayas at 4000-12,000 ft. in Tehri Garhwal, Kumaon and Jaunsar. Deoban (8000-9000 ft.), Jaunsar; Deota forests (8000-9000 ft.), Tehri Garhwal; Jamara camping ground (11,000 ft.), Damodar Valley, Tehri Garhwal; Khansar Patt, Garhwal; Kharamba above Mumdali, Dehra Dun Dist.; Kidarkanta (10,000-11,000 ft.), Tehri Garhwal; Kuari Pass (12,000-13,000 ft.), Garhwal; Kuthi Yankti Valley, Almora Dist.; Landour, Mussoorie; Mundalin forests (8000-9000 ft.), Dehra Dun Dist.; Mundali (8500 ft.), Jaunsar; Mussoorie; Mussoorie road to Kemti Falls; Naini Tal; Palanggadh, Byans, Almora Dist.; Phedi (4000-5000 ft.), Tehri Garhwal; Pindari glacier, Kumaon; Phulaldaru forests (11,000-12,000 ft.), Tehri Garhwal; Ramni (7000-8000 ft.), Garhwal; Ranikhet (5000-6000 ft.), Almora Dist.
44.	*Viola serpens* Wall. (Small herb)	Banafsha	Flowers and also entire plant	A small herb common in the woods above 7000 ft. in the hilly districts. China Thall (7000 ft.), Naini Tal; Deoban (7000-8000 ft.), Jaunsar; Jangla River banks, Ganges Valley (8000-9000 ft.), Tehri Garhwal; Kerwa, Jaunsar; Kidarkanta (10,000-11,000 ft.), Tehri Garhwal; Kinani Pani, Jaunsar; Kinani Pani to Jako Pass (8000-9000 ft.), Jaunsar; Konain (7300 ft.), Jaunsar; Mussoorie in woods above: Naini Tal; Suki to Jhala, Ganges Valley (8000-9000 ft.), Tehri Garhwal.
45.	*Withania somnifera* Dunal (Erect under-shrub)	Asgand	Root	Common in dry situations throughout the State. Allahabad; Banda; Dehra Dun; Kheri; Lucknow; Mala nadi, Pilibhit Dist.; Pilibhit; Raipur (2500 ft.), Dehra Dun Dist.

Winter Diapause in the Squatter Wasps *Antodynerus flavescens* (Fabr.) and *Chalybion bengalense* (Dahlb.) (Vespoidea and Sphecoidea)

BY

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AND

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(*With a plate*)

Antodynerus flavescens and *Chalybion bengalense* are both species of domestic solitary wasps who use pre-existing holes and cavities for their nesting activities. Very often they employ disused nests of two domestic mason wasps, *Eumenes esuriens* Fabr. and *Sceliphron madraspatanum* (Fabr.). We have also seen a nest of *Eumenes conoideus* (Gmelin) being used by an individual of *Chalybion bengalense* for this purpose, and have had this species emerge from a sticky nest, plausibly built by a female *Rhynchium nitidulum* Smith.

In September 1962 we began observations on the nest-building behaviour of *Eumenes esuriens* and *Sceliphron madraspatanum* in Bhubaneswar. Later, we caged in all nests presumed to have been built by these two species that we could find on the front verandah of our house in Bhubaneswar. From none of these did individuals of the presumed builder species emerge. From some, parasites emerged in the same season, and some on dissection contained unidentifiable debris. Most however had been squatted in by members of the two species we are now discussing. These are numbered, D, E, F, H, J, K, L, M, and R in Table I. *E.e.*1 (Table I) is a nest of *E. esuriens* that we watched being built, parasitized by *Stilbum cyanurum* and, after these had emerged, utilised by *A. flavescens* for its own nesting. Taub 1 (Table I)

and Taub 2 (Table II) were nests of *S. madraspatanum* collected from the verandah of another house in Bhubaneswar, for which we thank

TABLE I

Antodynerus flavescens

Nest	Probable builder	Caged	Larva removed	No. of Larvae	Pupated	Emerged	Sex	Length of pupal life (days)
D	*E. esuriens*	18-ix-62	..	1		19-v-63	♂	
			..	2		17-vi-63	♂	
			5-v-63	3	21-vi-63	29-vi-63	♂	8
			..	4		2-vii-63	♀	
E	do.	2-x-62	5-v-63	1	10-v-63	18-v-63	♂	8
			do.	2	22-vi-63	29-vi-63	♂	7
F	do.	do.	do.	1	10-v-63	18-v-63	♂	8½
			do.	2	10-v-63	18-v-63	♂	8½
			do.	3	6-vi-63	14-vi-63	♂	8
H	do.	do.	do.	1	5-vi-63	13-vi-63	♂	8
			do.	2	6-vi-63	14-vi-63	♂	8
			do.	3	22-vi-63	1-vii-63	♀	9
			do.	4	22-vi-63	2-vii-63	♀	10
J	*S. madraspatanum*	26-x-62	do.	1	8-vi-63	..	?	..
			do.	2	21-vi-63	30-vi-63	♀	9
			do.	3	23-vi-63	2-vii-63	♀	9
K	*E. esuriens*	do.	do.	1	5-vi-63	14-vi-63	♀	9
			do.	2	22-vi-63	30-vi-63	♂	8
L	do.	1-xi-62	do.	1	5-vi-63	13-vi-63	♂	8
M	do.	7-ii-63	do.	1	5-vi-63	13-vi-63	♂	8
R	do.	2-x-62	2-x-62	1	6-vi-63	14-vi-63	♂	8
E.e. 1*	do.	do.	5-v-63	1	10-v-63	18-v-63	♂	8
Taub 1	*S. madraspatanum*	31-xii-62	31-xii-62	1	15-v-63	22-v-63	♂	7½
			..	2		23-v-63	♂	
			..	3		12-vi-63	♂	
			..	4		12-vi-63	♀	
			..	5		14-vi-63	♀	
			..	6		15-vi-63	♀	
			..	7		16-vi-63	♂	
			..	8		19-vi-63	♀	
SR 1	..	14-v-63	14-v-63	1	6-vi-63	15-vi-63	♀	9
SR 2	..	do.	do.	1	8-vi-63	16-vi-63	♂	8
		do.	do.	2	22-vi-63	1-vii-63	♀	9
SR 3	..	do.	do.	1	8-vi-63	17-vi-63	♀	9
		do.	do.	2	21-vi-63	29-vi-63	♂	8
WV	*S. madraspatanum*	26-xi-62	..	1		13-vi-63	♂	

*nest seen being built by *E. esuriens* and being re-used by *A. flavescens* var.

Mr. and Mrs. Richard Taub. SR 1-3 were larvae collected from holes from which bolts had been removed in a door at our house. WV was a nest of *S. madraspatanum* found lying on the ground in the garden of

this house. SDJBN and SDJBS are two brackets of the wall fittings of some apparatus which had been removed, and the 4 screw holes in each of these brackets are regularly used by *C. bengalense* and *A. flavescens* for their nesting. The caging was done either by means of putting a piece of georgette over the nest or by putting the whole nest into a glass jar with a glass lid. The cocoons from SDJBN and SDJBS were put into small corked glass tubes. Those larvae that were removed from their nests and cocoons were also put in similar corked glass tubes. All these glass jars and tubes were put in a glass-fronted wooden cupboard.

Table II

Chalybion bengalense

Nest	Probable builder	Caged	Larva removed	No. of Larvae	Pupated	Emerged	Sex	Length of pupal life (days)
SDJBN	..	5-iii-63	5-iii-63	1	21-vi-63	2-vii-63	♀	11
			..	2		25-vi-63	♂	..
			5-iii-63	3	6-vi-63	16-vi-63	♂	10
SDJBS	..	do.	do.	2	6-vi-63	16-vi-63	♂	10
			do.	3	9-vi-63	..	♂?	..
Taub 2	*S. madraspatanum*	31-xii-62	..	1	..	18-vi-63	♂	..
			..	2	..	18-vi-63	♂	..
			..	3	..	29-vi-63	♀	..
			..	4	..	1-vii-63	♀	..
			..	5	..	6-vii-63	♀	..
			..	6	..	19-vii-63	♀	..
			..	7	..	22-vii-63	♀	..
			..	8	..	25-vii-63	♀	..
			..	9	..	25-vii-63	♀	..
			..	10	..	26-vii-63	♀	..

All these larvae were opaque and butter-coloured, had completed feeding, and had spun their cocoons. As can be seen from Tables I and II, the dates of the first pupations observed were 10.v.63 for *A flavescens* and 6.vi.63 for *C. bengalense* and the last emergences in our sample were on 2.vii.63 for the former and 26.vii.63 for the latter.

That both species pupated in several bursts suggests that some climatic stimulus other than day-length provoked this. If day-length were the relevant stimulus only a single peak would be expected.

The Plate gives the daily maximum and minimum temperatures recorded in the cupboard. The humidity figures plotted in this figure were not recorded in this cupboard but were taken indoors and were

supplied by the Commonwealth Institute for Biological Control, Bhubaneswar Station, to whom we are indebted for this facility. It seems from the graphs that temperature is not the factor which causes pupation of the diapausing larvae. Rise in humidity may be the reason, but the last few pupations observed occurred when humidity was decreasing. However, the results appear to point to a common external factor being responsible for pupation in both species.

Table III shows the length of pupal life in *A. flavescens* for the two sexes. There is no overlap between the two distributions, the males having a mean of 7·94 days and the females a mean of 9·125 days. The period considered is that from pupation to emergence from the pupal skin. The wasps fold their wings very soon after this, but we do not know how soon they would nibble their way out of their cells. *Chalybion bengalense*, when they come out of their pupal skin, have the abdomen distended so that the pellets of meconial excreta (Shafer 1949) show through the distended intersegmental membranes between the sternites and tergites as lateral rows of white patches. These pellets are expelled in the course of a day or two. Since wasps emerging in natural conditions do not show these white patches, pupal life was not considered complete until they had disappeared. We saw only three diapausing individuals of this species through pupal life. Two of these, which were males, took 10 days to complete it and the only female took 11.

TABLE III

LENGTH OF PUPAL LIFE IN *Antodynerus flavescens* VAR.

Pupal life (in days) ..	7	7½	8	8½	9	9½	10	Total
No. of males	1	1	12	2	..	..	..	16
No. of females	..	..	..	..	7	0	1	8

From Table IV, we can see that in *A. flavescens* there is a tendency for the over-wintering males to emerge earlier than the females, and in *C. bengalense* there was no overlap, though admittedly the sample is small. The likelihood of getting these results by chance is 1 in 3001 for *A. flavescens* and 1 in 2002 for *C. bengalense*.

We are making much larger collections in the early winter of 1963, and have more cells for which we have laying and sealing records. By dissecting the cells a few weeks after they were sealed, we have already confirmed that diapause is entered during October, after a previous development of a duration similar to that of the non-diapausing monsoon generations.

Thus the species *A. flavescens* has an annual cycle, the individuals being in diapause as late larvae between October and May. This has been confirmed by our notes on when imagines have been seen flying.

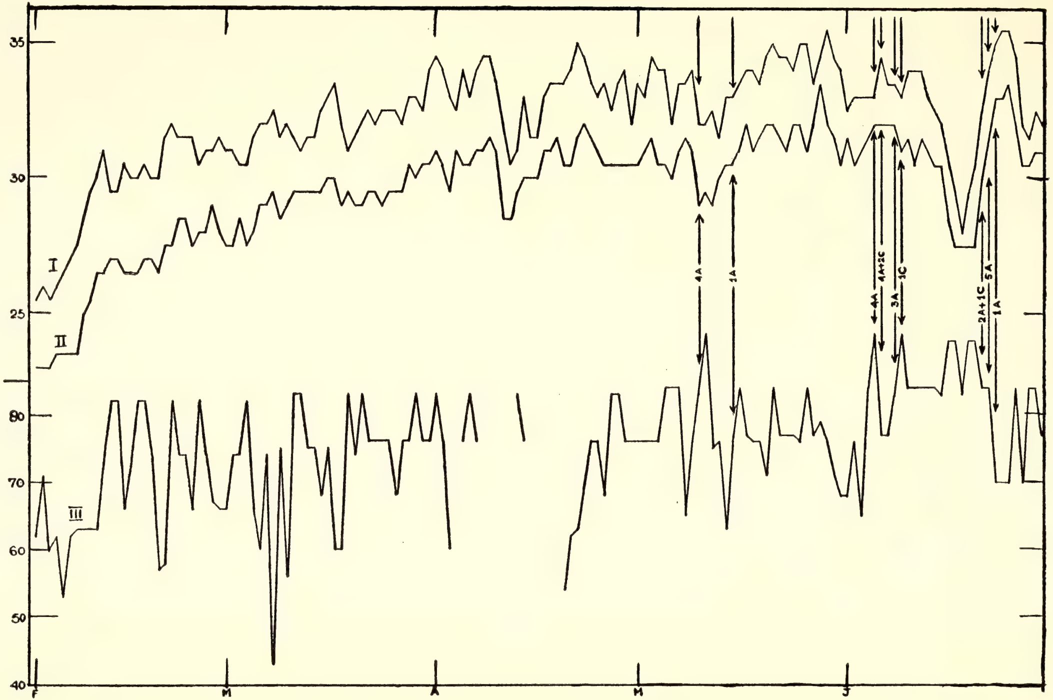
TABLE IV

DATES OF EMERGENCE OF THE TWO SEXES OF *A. flavescens* AND *C. bengalense*

Date	*A. flavescens*		*C. bengalense*	
	♂	♀	♂	♀
18-v-63	4			
19-v-63	1			
22-v-63	1			
23-v-63	1			
12-vi-63	1	1		
13-vi-63	4			
14-vi-63	3	2		
15-vi-63		2		
16-vi-63	2		2	
17-vi-63	1	1		
18-vi-63			2	
19-vi-63		1		
25-vi-63			1	
29-vi-63	3			1
30-vi-63	1	1		
1-vii-63		2		1
2-vii-63		3		1
6-vii-63				1
19-vii-63				1
22-vii-63				1
25-vii-63				2
26-vii-63				1
Total ..	22	13	5	9

In this, as in their proterandrous (Kohl 1918) pattern of emergence, they resemble the solitary wasps of temperate regions (Evans 1963, p. 5). However during their active period, which is the season of most rain in this part of India, there are several generations, i.e. they are multivoltine. The much smaller data presented here would suggest that *C. bengalense* is also proterandrous, and has an even shorter annual period of activity. However this must be a simplification as we have notes of two individuals seen working during the first week of March and a doubtful record for February.

The sample of *S. madraspatanum* nests collected was small and we have in 1963 observed larvae of this species, arising from eggs laid at the end of October, entering diapause. But neither in the much larger sample of *E. esuriens* nests here considered, nor in 5 nests which we



Maximum (I) and minimum (II) temperatures (°C.) and humidity % (III) for the months February-June 1963. Arrows indicate the dates of pupations, numbers indicate number of larvae and letters the two species.

have observed being built in October 1962 and 1963, and in which the inmates of 28 cells completed metamorphosis, have we found any individual of *E. esuriens* which was in diapause. Even though these animals emerged in November, we have not seen any member of *E. esuriens* building after 3rd November, or during December, January, or February. Roubaud (1916) considers that some species, including perhaps *E. esuriens*, migrate to different regions during the different seasons in parts of Tropical Africa where these are well marked. Do similar migrations occur in India ?

We are grateful to Dr. J. van der Vecht of Leiden, The Netherlands, who has identified individuals of both the main species discussed. He tells us that our population of *A. flavescens* is atypically pigmented.

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In Memoriam

EDWARD OSWALD SHEBBEARE

It is not always that the heavens 'blaze forth the death' of a great person. More often than not, nature has a curious way of withdrawing her top gentlemen quietly—with but a muffled sound as of a great tree falling on the soft leaf-littered floor in the depths of the forest. Such was the passing away of Edward Oswald Shebbeare, formerly of the Indian Forest Service, on the 11th of August 1964 at the age of 80, at his home in South Newington in Oxfordshire, U.K., where he settled after retirement.

He belonged to that rugged type of forest pioneers of an earlier day who possessed exceptional courage, determination, and devotion to their purposes, and were undaunted by physical hardship and the utter loneliness of months in a strange land among strange people. He joined service in the Sunderbans in 1906, became Conservator of Forests (then Head of the Forest Department) Bengal, in 1923, and before he retired in 1938 was Chief Conservator of Forests, United Provinces, for some years. Those were years of hard work and substantial contribution to the causes of forestry and wild life.

To his credit goes the perfecting of the method of raising plantations of trees (in replacement of clear-felled forest) by *taungya*, that is in conjunction with field crops. In his forest inspections he was never without his *kukri* dangling in its sheath from his belt; every now and then he would fish it out to cut a blaze in the stem of a tree, study its colour, its smell, its 'feel', as well as any exudation from it. He thus collected a number of useful tips for the identification of trees in the absence of flowers, and sometimes even of leaves. All easily visible (macroscopic) features of stem, twig, leaf, flower, and fruit were carefully noted down and illustrated by patient drawings (sometimes with his left hand, for he was ambidexterous) during long evenings in camp from specimens collected each day. His first fair typescript and sketches were lost when he was caught prisoner of war in Malaya in the last World War, but with characteristic patience and determination he made a fresh compilation from rough sheets after his release in 1946. These were eventually published in 1956 by the West Bengal Government in a book, THE TREES OF THE DUARS AND

TERAI. The curious part of it was that he was not a trained botanist. One is reminded of Burns's lines:

> 'Give me a spark of Nature's fire
> That's all the Learning I desire.'

He was intensely interested in all aspects of the sylvan scene: mountains, rivers, trees, animals, and birds—and fishes. He was joint author of a monograph, FISHES OF BENGAL.

By 1930, the Great Onehorned Rhinoceros was facing near-extinction in Bengal, its population having been decimated by persistent, dare-devil poaching. Getting the Bengal Rhinoceros Preservation Act passed in 1932 and setting in motion a vigorous campaign against poachers, Shebbeare was responsible for giving a further lease of life to this rare and interesting pachyderm in that Province, where Jaldapara has virtually been a sanctuary since then; the rhinoceros population therein has steadily built up. His undying interest in tropical flora and fauna led him to accept, after retirement from the Indian Forest Service, the position of Chief Game Warden in Malaya, the tenure of which was unfortunately cut short by the war and his internment by the Japanese in 1942.

His *magnum opus* was SOONDAR MOONI, which purports to be the story of an Indian elephant—before and after capture, but Shebbeare tried to condense in this book the jungle lore which he gathered through more than three decades of forest life. Every page of it, therefore, is full of absorbing interest.

Some of his contributions to the *Journal of the Bombay Natural History Society* are:

Altitude to which elephants ascend. 1915, Vol. **23** : 770.
A tentative list of the vertebrates of the Jalpaiguri District, Bengal. (With Chas. M. Inglis, W. L. Travers, and H. V. O'Donel). 1919-20, Vol. **26** : 819-825, 988-999 ; 1920, Vol. **27** : 151-162.
Occurrence of *Psammophis condanarus* ? in Berar. 1937, Vol. **39** : 871-872.
Malayan National Park. 1946, Vol. **46** : 558-562.
The Hispid Hare, *Caprolagus hispidus*. 1961, Vol. **58** : 266-267.

Although of stocky build, Shebbeare was a good mountaineer. This, together with his knowledge of the local terrain and his winning way with the hill people (for he was human to the bone), was responsible for his being chosen as Transport Officer for the Everest Expeditions of 1924 and 1933 and the Kanchenjunga Expeditions of 1929 and 1931. It was on the second trip to Everest that he managed to achieve his secret ambition, to reach the 23,000 ft. high North Col—much against the express order of the leader Hugh Ruttledge, for Shebbeare was by then 50.

Like all truly great men he was warm-hearted and modest—no city airs for him. Even at Darjeeling he was to be found knocking about in jungle boots and khaki breeches. At Siliguri, after a day spent in the forest, he would (after a bath) change into khaki shorts for dining at the Railway Restaurant! Richard Casey (Governor of Bengal in 1944-46) wrote of him: 'Shebbeare is a very individual personality—tough and hard. I am told he seldom wore socks. When we arrived at Nilpara he was very simply attired in shorts and an old khaki shirt and his rawhide boots and socks. Someone said that the socks were overdoing it a bit, and he said, "Oh, you've got to cut a bit of dash on these occasions".' And again: 'He'd be lost and unhappy in a big city. but he is completely happy and at home in the jungle'.

'More secrets of knowledge', wrote Roger Bacon seven centuries ago, 'have been discovered by plain and neglected men than by men of popular fame'. The keenness of such knowledge-seekers never gets blunted. Even in the days of his retirement at South Newington, Shebbeare eagerly sought out people returning from India and got himself posted up-to-date with what was doing there in forestry and wild life conservation. He sometimes spoke on such themes to the students of the Forestry Institute at Oxford. It was characteristic of him that even the day before his death he had been to London to attend a meeting of mountaineers—quite fit—but did not feel too well on his return. Next morning the angel of death found him in his garden chair and softly whispered into his ear of more interesting things in another world. As Browning expressed it with his characteristic flash of insight:

'Help me with knowledge—for Life's Old—Death's New!'

V. S. Rao

Reviews

1. ANIMAL SPECIES AND EVOLUTION. By Ernst Mayr. pp. xiv+797 (24·5×16·5 cm.). Harvard, 1963. Belknap Press Price $ 11·95.

Most naturalists encounter the discussion of a species under somewhat intimidating circumstances. As soon as we wish to publish an observation, we find we have somehow to protest and produce evidence that we have identified the organism we are discussing correctly, and it is frequently suggested that we had better not take the responsibility ourselves but produce a specimen for an expert. If we find such reliance on someone else for an essential step in our reasoning somewhat disquieting and attempt to study systematics for ourselves, there is a faintly Brahminical horror that we have looked into some forbidden knowledge which it would be disastrous for us to apply.

Since the study of living creatures became a separate 'subject' in Europe in the 16th century, it has been part of the discipline of this study to increase the precision associated with the word *species*. It cannot be too repeatedly emphasized that the precision associated with this word in its biological context is truly formidable. There must be very few words the use of which more immediately reveals the competence of the speaker or writer.

This development of precision in definition is not so much an emancipation from the particular myth of creation which had been assimilated by the Christian religion, as a development of the meaning of the word (and related words) in philosophy, which in its turn developed from educated usage in the classical world. During this period it has been usual to make short definitions of a species (in this biological sense). I am sure students still have to produce them in examinations. Dr. Mayr has produced a very famous definition, but it is implicit in this book, and I think he means it to be, that these aphorisms have lost their value. Mayr's definition is so simple, in such unpompous English, that it is continually misquoted in complete good faith. It does not by its form emphasize its precision; the not very dramatic words hide how much thought lies behind their choice. A species is a precise thing, but it is a complicated thing, and a snap definition is no help to anyone who needs to identify an individual organism, describe a new species, design an experiment to illuminate

some anomaly he has discovered, or provide numerical examples for a theoretical argument.

A species is a complicated thing because it is a group comprising a very large number of individuals. These individuals are not all alike, and, as soon as we consider more than a very few of them, either by collecting a series, or by observing how they behave among themselves, we discover that they are more or less divided into local populations. The existence, both of individual variation, and of countless subdivisions of the total community, is taken for granted among us human beings, and in these respects we are typical of other species. An appreciation of the immense amount that has been discovered about the population structure of animals will not only facilitate, but add a new depth to our observations.

Here however we approach a difficulty. Dr. Mayr has written a work of scholarship and his discussion integrally includes a genetical vocabulary which, despite the writing of E. B. Ford, has not yet permeated the thinking of everyone educated and intelligent enough to be a naturalist. Worse—Dr. Mayr's vocabulary is very modern, and consists of many abstract terms, which may be provisional and ephemeral, but do express the provisional concepts of the workers who are at present most actively considering the subject.

Dr. Mayr himself will to some extent reinforce the naturalist's intellectual withdrawal when a genetical concept rears its ugly head; and it is emphatically not his business to explain or simplify these concepts in a book of this kind. However, the disparaging remarks which he is making about what he calls 'beanbag genetics', in this and other recent writings, are to some extent spurning the base degrees by which he ascended, if not fouling his own nest. It is clear that he has never been fascinated by the experimental material of formal genetics. Formal genetics somewhat resembles the elementary inorganic chemistry such as is studied for Inter. Both require reagents which are nowadays specially prepared for demonstration and analytical purposes, and which are seldom encountered in everyday life. In both studies these are unusually simple, or pure, but in a few respects only. That the facts of heredity were discovered in the first instance is due to the taste of a few biologists who chose to work with stocks of animals and plants that already possessed this simplicity for other reasons. These were of animals, such as poultry, rabbits, mice, and cats, and of plants, such as peas and stocks (*Matthiola*), which existed in many variants, but had not been exposed to centuries of intensive isolation and selection to form breeds and the various plant equivalents of these. Darwin almost discovered the first law of Mendel working

with a polymorphism, and Doncaster discovered sex linkage using another example of such a system, the differences between individuals that make a species polymorphic being again unusually simple in their genetic determination.

Without the completest facility in thinking in terms of the facts today subsumed under formal genetics, the application of them either to crop improvement, which may be compared to organic chemistry, or to the structure of wild populations, which may be the equivalent of biochemistry, could not have developed. Dr. Mayr does assume his readers to be familiar with the verbal vocabulary of population genetics, though, as has been pointed out by others, not the more fertile algebraic vocabulary.

On p. 422 Mayr writes: 'it is rather difficult to establish a selective model to account for the lengthening of generation time, the lengthening of the immature stage . . . '. A recent book by Wynne-Edwards[1] does offer an answer to this puzzle. This must be in some way a step towards the correct answer, as it brings order to such a large number of facts the previous explanations of which were unsatisfactory or non-existent. However Wynne-Edwards's hypothesis is not unqualifiedly accepted, largely because though the benefits of the adaptations he explains are undoubted it is difficult to hypothesize a 'selective model' that would function on our present picture of the genetic structure of populations. One possible answer is that populations may sometimes be much more closely genetically integrated than has previously been suspected, and that some genetic systems at least may have a binding structure of a degree which, today, we think can only be achieved by a learnt culture.

However, the consideration of the genetical structure of natural populations and how these differ among themselves has given us virtual certainty about how such differences have arisen and what further conditions will make them increase or cause them to regress. And considering these genetical differences in this way, we see that their increase beyond critical limits results in the splitting of the species into two. These limits, though critical, are not historically abrupt, and populations which are in an intermediate stage are available for experiment. Dr. Mayr describes the sequence of events which can be presumed to have occurred (and the presumption is often excellent) in every example of metazoan speciation that has been analysed, which are now a considerable number, and include members of many

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[1] V. C. Wynne-Edwards: ANIMAL DISPERSION IN RELATION TO SOCIAL BEHAVIOUR. Edinburgh and London, 1962.

major groups. Nevertheless, I regret Dr. Mayr's insistence, for theoretical reasons, that this process is the *only* speciation process that can occur in the higher animals with sexual reproduction. Though I think he has answered existing criticisms, it is also probable that he will be assumed to have already answered arguments that in fact have not yet been formulated. Dr. Mayr gives examples, from the history of this study, of fundamentally new arguments which were not recognized as such, either by their authors, or their readers. I fear that Mayr may have inhibited certain musings over data that would otherwise be made because, by having already countered an argument *something like* the one consciously being formulated, he has *a priori* discredited a whole range of arguments which have not yet been produced. The most serious consequence of such a possible curtailment of freedom of *thought* (*N.B.* not freedom of expression), is that certain facts will not be noticed, because there are no theories or hypotheses to give them valence to the observer.

My other criticism of Mayr is for a repeated complacency concerning our ignorance of the *functions* of the morphological characters which form so large a part of what we attend to in the organic world, especially those which are constant in form. When considering, for example, taxonomic variation in genitalia, the nature of the patterns of the morphs that form a polymorphic population, or the characters actually used by taxonomists in their descriptions, he repeatedly makes the following point: 'Colour, pattern, or some structural detail may be merely an incidental by-product of a gene maintained in a gene pool for other physiological properties'. I do not believe this. If Dr. Mayr were more familiar with mutants used in experiments in formal genetics he would have noticed that pleiotropisms that are 'incidental by-products' are wildly variable, and a consideration of Waddington's canalization argument would explain to him why this must be so. The maintenance of a constant phenotype in a varying environment must depend on compensatory processes, which are *necessarily* variable in order to be able to compensate. The variation of urine is the best analysed, but an entirely typical example. In a living organism, if a morphological character is constant *in our evaluation*, it is by definition canalized. Therefore there is a selection pressure to maintain that canalization, and that selection pressure must act on features of the character very closely correlated with those we evaluate by our senses and our techniques. In occasional situations we can appreciate the selection pressure that has produced every single morphological detail in an animal, for example in the details of a mimic butterfly. If we are content to dismiss the admittedly closely

similar details in the pattern of the model as incidental by-products, we are evincing lack of curiosity concerning the nature of the selection pressures under which animals actually evolve. This blindness of Mayr's is curious because elsewhere he uses the argument that constancy, both of a frequency and of a phenotype, is evidence for a selection pressure to maintain it.

The origin of species does not comprise the whole of evolution theory, but following Darwin it is the most emphasized side. I think this is good, because these questions are available for experiment in a large number of ways, as the study of the evolution of larger groups is not. Also it is probable that the most fruitful approach at the moment to other aspects of evolution is to rephrase our questions, as Mayr shows we can, so that they can be considered as problems of speciation.

Very early in his book, Mayr lists disciplines which are necessary to contribute to evolution theory. This is a very proper attack on specialization, and I hope it will be heeded in Indian academic life, but I think Dr. Mayr is being too modest. I think it could be substantiated that, as a historical fact, the evolution theories that have stuck have been formulated by systematists. I am quoting from memory over twenty-five years, but I attribute the point I am making to Darwin. If I remember correctly, Darwin replied to someone nagging him to write up his evolutionary theories by saying he must write his cirripede monograph first. His point was not that he must finish a drab chore before he took up an exciting one (the cirripedes had not been begun) *but* that until he himself had done a piece of work in systematics he was not qualified to attempt the essay which became the ORIGIN. Mayr has this qualification, which I think can only be obtained in systematic work. It is an appreciation of the immensity of the problem.

H. SPURWAY

2. BIRDS FROM *BRITANNIA*. By H.R.H. The Duke of Edinburgh. pp. 62 (25 × 18 cm.). Numerous photographs in black and white. London, 1962. Longmans, Green and Co. Ltd. Price 21*s*. net.

In BIRDS FROM *BRITANNIA* H.R.H. The Duke of Edinburgh has put together a pithy and personal record of his bird photography in the course of the voyages of the Royal Yacht *Britannia*, which took him to the tropical seas, the southern oceans, and the Antarctic. There

are also forty-eight pages of excellent photographs, and finally an illustrated appendix descriptive of the birds photographed by the author. This appendix is the work of Captain G. S. Tuck, Chairman of the Royal Naval Bird-Watching Society. The whole book is an excellent introduction to the labours and rewards of bird-watching and bird photography for those who are not already practitioners, and to those who are it serves to introduce a strange and remote bird world which most of us will never see. Mollyhawks, Wanderers, Nellies, Noddies, and Stinkers are unlikely to pass before the ordinary man's eye or camera lens, but they can be found in this book. Finally, any amateur who thinks of writing up natural history notes or observations will find here a model style, as compact as it is lively.

J.G.

3. THE FAUNA OF INDIA INCLUDING PAKISTAN, BURMA AND CEYLON : MAMMALIA (Second Edition). Vol. III. Rodentia. By J. R. Ellerman. With an appendix by M. L. Roonwal and B. Biswas. Part 1, pp. xxx+482, with 34 figures; Part 2, pp. lii+483-884, with 20 figures and a map; 23·5×16·5 cm. Calcutta, 1961. Zoological Survey of India. Price for Parts 1 and 2 together: Inland Rs. 46; Foreign 107*s.* 4*d.* or $ 16·56.

The two parts comprising this third volume of the second edition on the Mammalia in the series FAUNA OF INDIA are devoted entirely to the Rodentia and have been written by Sir John Ellerman, an acknowledged authority on this complex Order. They maintain the high standard of the earlier volumes on the Primates and Carnivora by the late R. I. Pocock, and, like these volumes, are based on the extensive collections of the British Museum (Natural History). Although the work is avowedly concerned only with the rodents of the Indian sub-continent it cannot be considered parochial: the author notes that his conclusions are derived from the examination of some 13,000 specimens from Asia, Europe, North Africa, and Australia, and throughout the work reference is made to the study of specimens from the adjacent parts of the Palaearctic and Malaysian regions. The editor of the series is to be congratulated on the breadth of this concept, which permits a soundly based study: if for no other reason, a work of a scope such as this merits careful examination.

The general objective of the series FAUNA OF INDIA 'is to produce authoritative taxonomic monographs of a high scientific standard on the

different groups of Indian animals . . .'. There can be no doubt that this aim is admirably fulfilled by the present volume. It is a comprehensive and detailed taxonomic review of the Indian Rodentia, based on a broad spectrum of their diagnostic features and prepared in a critical and objective fashion. It follows the general pattern set by the earlier volumes on the Primates and Carnivora. The Order Rodentia is defined and the reasons for excluding the lagomorphs as a separate Order discussed in the introduction, which includes remarks on the classification of the Order with a key to the families and subfamilies of Indian rodents and a brief review of their distribution. The systematic account provides a definition and discussion of each family, with a key to its included genera. Diagnoses of genera and species follow in considerable detail, with especial emphasis on cranial and dental characters. Keys to species and subspecies are provided where necessary: the diagnostic features of subspecies are reviewed in some detail, with external and cranial measurements. Distributional data are provided at all levels and precise localities are given for the Indian specimens examined during the preparation of the work. Extant problems in the taxonomic study of Indian rodents are discussed in considerable detail at whatever level of classification they occur and the author sets out his conclusions clearly and concisely. The habits and ecology of Indian rodents receive less attention than was devoted to these topics in the earlier volumes on Primates and Carnivora, a reflection of the fact that rodents are less easily observed.

This volume is the first detailed study of the rodents of the Indian sub-continent to appear since the publication of part 2 of the first edition of the volume on the Mammalia by W. T. Blanford in 1891, and it reflects very clearly the considerable advances that have been made in Indian mammalogy since that date. Blanford had under consideration a total of 21 groupings of simplicidentate rodents which he thought of generic validity. These occupy some 90 pages of text. Seventy years later, the present work contemplates a total of 46 such groupings, involving a text nearly ten times as long as that of Blanford. The increase in knowledge is largely due to the Bombay Natural History Society, whose initiation of the Mammal Survey of India, Burma, and Ceylon began a great upsurge of interest in the detailed study of Indian mammals. It may be said in truth that without the work of the Survey, the present study of the rodents of India could never have appeared in its present form, for the Survey provided for the first time the extensive series of specimens without which no comprehensive study of a fauna can be made. Hitherto, the principal work on the large collections of rodents obtained by the Survey has

been a long series of papers by Wroughton and Thomas published in the early part of this century and summarized by Wroughton. Now, in the present volume, this has been critically reviewed and the results of the Survey and other collections expanded into a comprehensive treatment. The author has had the advantage of having much original material for his studies, supplemented in many cases by extensive series derived from further collecting, and has been able to take a wide view of the rodent fauna of the region.

Sir John Ellerman is best known for his monumental volumes on THE FAMILIES AND GENERA OF LIVING RODENTS and it is abundantly evident that his undoubted abilities as a diagnostician have been fully employed in his study of the Indian Rodentia. His definitions at the level of the family, genus, and the species are a model of their kind within the purpose of the work and especially in the context of cranial and dental characters. Meticulous attention to detail has been applied at the level of the subspecies, wherever sufficient specimens were available to justify such treatment. As might be expected, at this level of classification, less importance is attached to cranial and dental characters which to a large extent are replaced by those of absolute size, proportion, and colour, and it is here that the value of the extensive series examined by the author becomes apparent. For the first time for many widespread Indian species, a detailed comparison of many of their subspecies one with the other has been made, so that the pattern of regional variation becomes clearer. This work by Ellerman assumes an importance denied to the studies by Wroughton and Thomas, which were primarily those of analysis, in contrast to the synthesis practised in the present study.

The text of this volume was completed for publication in 1946 but for various reasons did not appear in print until 1961. However, the author has included his later thinking on the minor classification of Indian rodents. For example, in the genus *Rattus*, he has included the subgenera *Leopoldamys* and *Berylymys* which he proposed in 1947 and his views on the vexed question of *Rattus rajah* and *Rattus surifer* as expressed in the present work are in accord with his opinions on the point foreshadowed in his 'Key to the Rodentia inhabiting India, Ceylon and Burma' (1947, *J. Mammal.* **28** : 249-278, 357-389) and set out in the CHECKLIST OF PALAEARCTIC AND INDIAN MAMMALS (1951) and the INDEX TO CHASEN (1940) A HANDLIST OF MALAYSIAN MAMMALS (1955). In this way he has embodied his more recent views into the text, which do not always agree in minor detail with the conclusions of the third volume of THE FAMILIES AND GENERA OF LIVING RODENTS, itself completed in 1946 but not published until 1949. This situation

is further rectified by the provision of an appendix by M. L. Roonwal and B. Biswas, listing rodents described as new from the region during the period 1946-1960, with a summary of their diagnostic characters. It is clearly less easy to draw attention to further work which modifies or expands the conclusions expressed in the text but this has been done in a few cases by the provision of a footnote. The work consequently suffers little from the delay in publication: such published work as has been unavoidably excluded does not affect it to any serious extent.

Attention may be drawn to a few small points that are misleading or inconsistent. The measurement known in mammalogy as condylobasal length is defined on p. 11 as 'from the occiput to the front of the incisor' as opposed to the more usual method of obtaining this value which takes as its posterior points of reference the hindmost surfaces of the occipital condyles and as its anterior point the foremost part of the premaxillae, at or close to the mid-line. Inconsistencies can be found in the spelling of place names: for example, the locality Charwa, in Cutch, appears variously as Chalwar, Charwa, and Charwar. Similarly, skin and skull studies do not always correspond precisely with each other or with the text: for example, in the table of external measurements for *Rattus niviventer*, it is said under *R. n. mentosus* that 'the following skins may also belong here', yet in the table of cranial measurements for this species the skulls associated with certain of these skins are listed definitively as *R. n. mentosus* while in the text the localities whence these skins came are included definitively within the distribution of that subspecies. The detailed and valuable tables of measurements could perhaps have been improved by the consistent specification of the specimens to which the measurements refer: this has been done to some extent by quoting the Museum registration numbers (or collector's numbers for unregistered collections) for all of the skulls measured but such numbers are quoted only rarely for the skins of which external measurements are given, thus rendering impossible the association of the two sets of measurements in all but a few cases. These minor criticisms do not minimise the value of the book and some may derive from its preparation during time of war when the collections and libraries of the British Museum (Natural History) were widely dispersed.

There can be no doubt that Sir John Ellerman has made a major contribution to Indian mammalogy. For the first time the student has available a comprehensive treatise on the Rodentia of the Indian sub-continent which brings together the plethora of names applied to this widely varied group and which provides a thorough comparative study of the majority of named forms from the region. The author

has brought to his subject a remarkable power of detailed diagnosis and definition which has resulted in a clear and unified treatment of certainly the largest, and probably the most diverse, group of Indian mammals. This volume will remain for many years the standard text on the Rodentia of the Indian sub-continent and, as such, will be indispensable to any student of the mammalian fauna of that region or of the Order Rodentia as a whole.

J. E. HILL

4. MARSILEA. By K. M. Gupta. pp. vi+113 (24×16 cm.). With two photographs in monochrome, 13 tables, and 40 figures including 1 map. New Delhi, 1962. Council of Scientific and Industrial Research. Price Rs. 16, or 33*s*., or $ 5.

This is the second in the series of Botanical Monographs taken up by the Council of Scientific and Industrial Research, India. The subject of this monograph, after the first on *Gnetum*, is well chosen, and has been admirably executed by Dr. K. M. Gupta. The author has carried out critical studies on Indian species of *Marsilea* for several years and has taken considerable pains to collect the materials for this monograph.

The treatment of the subject, as in the previous monograph, is very good. The reproduction of original descriptions of the various species is a very happy thought, but one is puzzled why the English translation of the description is not given in each case. The inclusion of the pictures of two botanists, Alexander Braun and John Gilbert Baker, who made valuable contributions to our knowledge of *Marsilea* is a happy thought.

This work comprises previously published and unpublished morphological, ecological, taxonomical, embryological, and cytological studies of the several species of *Marsilea*, especially the Indian species of the genus. The comparative morphological studies of two different species, *M. minuta* (hydrophytic) and *M. aegyptiaca* (xerophytic), from Rajasthan in India have provided the material for the data on Morphology and Anatomy for the monograph. A summary of developmental studies by Campbell, Demalsy-Feller, Johnson, Feller, Andrews & Sharp, and Kolhatwar is included. The meagre work on cytology and ecology is summarized here with the help of figures and tables. The portion on Systematics is dealt with in considerable detail including three long tables and includes the synonymy of each species. The monograph ends with a short theoretical discussion. It has been

pointed out by the author with the help of observations in various fields that further intensive studies on the aspects of experimental morphology, ecology, cytology, etc. of this group of plants are needed. A recent report on the effect of darkness and infra-red light on the conversion of the water form of *Marsilea* to a land form is interesting. (See J. J. Gaudet in *Science* **140** : 975, May 1963.) The figures are all excellent and the tables very explanatory. The author and others associated with him in this work are to be congratulated on giving us a very valuable monograph.

P. V. BOLE

5. BIRDS OF ISRAEL. By Paula Arnold. With a Hebrew translation by Rachel Kellner. pp. 107 (27·5×21 cm.). With 15 coloured and 15 monochrome plates by Walter Ferguson. Haifa, 1962. Shalit Publishers Ltd.

This very welcome addition to general ornithological literature is addressed to the layman and gives short descriptive notes on forty-eight species of birds accompanied by beautiful illustrations. Many of the birds described are common to Israel and India. A list appended to the text enumerates about 350 or more species occurring in Israel. One cannot help regretting that the work was not extended to include more birds, and that the book was not given a handier size and a sturdier binding suitable to a handbook to be carried in the field. The reviewer hopes that there will be sufficient response to the first edition to encourage the author to undertake a revised and enlarged edition.

The author tells us that the Great Spotted Cuckoo (*Clamator glandarius*) baby does not destroy its foster siblings, the reason according to her being that the foster parents, the Hooded Crow (*Corvus corone*), owing to their varied diet have no difficulty in feeding the intruder in addition to their own young ones. It would be interesting to investigate whether any of our cuckoos behave in this fashion.

D.E.R.

Miscellaneous Notes

1. DISTRIBUTION OF THE TOMB BAT, *TAPHOZOUS PERFORATUS PERFORATUS* E. GEOFFROY

Ellerman & Morrison-Scott (CHECKLIST PAL. INDIAN MAM., 1951, p. 104) give the Indian distribution of the Tomb Bat, *Taphozous perforatus perforatus* E. Geoffroy, as Cutch and Kathiawar. Brosset (*J. Bombay nat. Hist. Soc.* **59**, 1962, p. 33) recorded it from Ahmedabad city and northern Gujarat, and Prakash (*Rec. Indian Mus.* **59**, 1963, p. 156) from Jodhpur and Barmer, Rajasthan. Outside Indian limits, the form includes Egypt in its range. It has, therefore, been considered more or less a typical desert form. Three specimens (2 ♂♂, 1 ♀) were collected by the writer in September 1963 near Jabalpur city, with average annual rainfall of 1433·4 mm., maximum monthly rainfall of 659·9 mm., and maximum relative humidity of 92, as recorded during the last ten years. This shows that the form is not confined to desert areas.

All the specimens were collected while flying near sparsely forested country in the same locality. The nature of the diurnal habitat in the area is so far unknown. Although several other species of *Taphozous* are common around Jabalpur, this form has not been met with again and, thus, appears to be rare.

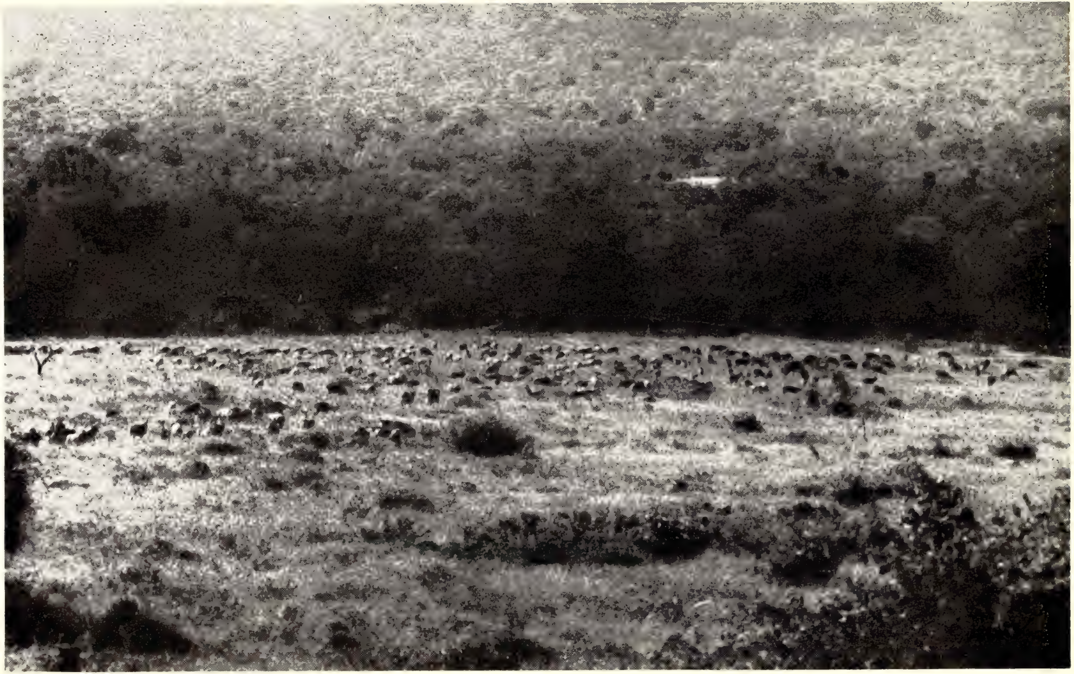
Although the external and the cranial measurements are the same as recorded by Brosset (loc. cit.), the specimens appear darker in coloration. One of them has a reddish brown patch on the back. Pending availability of more specimens, no geographical significance can be attached to this character since there is considerable colour variation in Indian bats.

CENTRAL REGIONAL STATION,
ZOOLOGICAL SURVEY OF INDIA, H. KHAJURIA
JABALPUR,
May 14, 1964.

2. A LARGE HERD OF CHITAL

(*With a plate*)

I enclose a photograph of a very large herd of chital numbering over 500 animals I saw at the Avarahulla Reserve of the Mudumalai Wild Life Sanctuary in the Nilgiris on 25-10-1964. The forest was



A large herd of Chital, Mudumalai Sanctuary

(*Photo : E. R. C. Davidar*)

until very recently a shooting area under the management of the Nilgiri Wild Life Association.

I wonder if such a large herd has been recorded before.

THE NILGIRI WILD LIFE ASSOCIATION,
OOTACAMUND, S. INDIA, E. R. C. DAVIDAR
December 4, 1964.

3. BALEEN WHALE IN GULF OF MANNAR CAUSES DEATH OF TWO FISHERMEN[1]

On 26 May 1961, a local Tamil newspaper *Thina Thanthi* carried a news item of a fishing boat in the Gulf of Mannar off Punnakayal, south of Tuticorin, being attacked by a large fish, resulting in the death of two of the five fishermen in the boat. In June 1961, while on tour to Tuticorin, I visited Tiruchendur Government Hospital where the injured were said to have been admitted and also Punnakayal village, to obtain first-hand information about the incident. It transpired that one of the survivors, Jayaraj Fernando aged 37, was admitted to the hospital with injuries on the forehead and back on 24 May 1961, the day on which the incident occurred, and was discharged on 5 June 1961.

At Punnakayal village I met four survivors and gathered the following information: Fishing about seven miles off Punnakayal on 24 May 1961, at about 04·00 hours after hauling in the gill nets (catch almost exclusively *Sardinella* spp. and *Chirocentrus* spp.), the six fishermen (not five as reported in the paper) were resting, waiting for favourable winds to sail shorewards. Suddenly, without any warning, a huge monster reared up and fell across the boat, smashing the sides and capsizing the boat. Two of the fishermen, Antony aged 28 and Tai Tones aged 35, were killed instantaneously being crushed against the boat. The others were thrown into the water, dazed and injured, Jayaraj Fernando more so, but they managed to cling on to the capsized boat and were picked up shortly after by one of the passing fishing boats.

In the twilight the animal appeared to be blackish on its upper side and pale whitish ventrally, and was estimated to be about thirty

[1]Published with the permission of the Director, Central Marine Fisheries Research Institute, Mandapam Camp.

feet in length. As the animal fell on the boat and slid over it, bits of its skin were found sticking to the jagged edges of the broken timber. I was able to examine a few of these bits, collected and kept by the fishermen. They indicated that the animal was not a fish as reported, but a cetacean.

It appears that on the day prior to this incident (on 23 May 1961) the same animal or one similar to it got entangled in some nylon fishing nets (gill nets) set in that vicinity but escaped, after badly damaging the nets. On several previous occasions fishermen have seen such monsters which they know do not belong to the true fishes, but are related to the *Ongil* (dolphins and porpoises) and which, on account of their enormous length, they call *Uravi*, *Panai uravi*, or *Timingalam*. They differentiate them from the Whale Shark, which is also occasionally found in the Gulf of Mannar and is known locally as *Panaimeen*, by their horizontal tail flukes and the two blow holes, from which 'fountains of water are spouted from time to time'. I was told that occasionally these whales are known to approach and lie alongside fishing boats in the fishing grounds, when even their eyes 'which are almost like those of a calf' can be seen! Also, on rare occasions, pairs have been seen in the fishing grounds off Tuticorin in waters six fathoms deep to rear the anterior part of their bodies above the water and fall back with a resounding noise, which antics fishermen consider as mating play.

On the information gathered there can be no doubt that the animal responsible was a baleen whale, but specific identification is not possible except, on the basis of the size, to presume that it was one of the smaller species, most probably the Lesser Rorqual, *Balaenoptera acutorostrata* Lacépède. The occurrence of this species in the Gulf of Mannar during the month of May is not unusual, as there is a record of the stranding of a 21-foot *B. acutorostrata* on 19 May 1937 at Mannar on the west coast of Ceylon (Deraniyagala 1948, *Spol. Zeyl.* **25**).

The purpose of this note is to draw attention to this unusual incident, which to my knowledge is the first of its kind to be reported from the Indian Seas.

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE,
MANDAPAM CAMP,
August 18, 1964.

E. G. SILAS,
Pool Officer, C.S.I.R.

4. SELECTIVE SEX REGULATION

Interesting possibilities are raised by the recent studies of Dr. B. C. Bhattacharya on Artificial Insemination (A.I.). While still under experimental study, evidence has been found to suggest that sperm carrying the X-chromosome (which give rise to a female fertilised ovum) can be separated from Y-chromosome-carrying sperm, the selective use of these yielding offspring of the desired sex.

Dr. Bhattacharya, a veterinarian, first started this work at the artificial insemination centre in Calcutta. A request was made by a farmer that his cow be inseminated late in the evening, since insemination later in the day gave rise to more female calves, while insemination in the morning gave rise to more males. On going over the records, Dr. Bhattacharya found that there was, indeed, a slight but definite preponderance of male calves from cows inseminated in the morning, and of females when A.I. had been done late in the day.

This finding started the present studies. In spite of lack of interest, scepticism, and active discouragement (arising partly from the fact that numerous claims have been made in the past which have not been substantiated by further investigation) Dr. Bhattacharya has persisted in his work. He makes *no* claims at present, beyond the obvious one that this question needs more intensive study. His preliminary work showed that, on standing, there is a certain degree of sedimentation in the tube of semen, and that the sedimented layers, richer in sperm content, show a higher proportion of X-carrying sperm. Since semen for A.I. was usually collected early in the morning, stored, in suitable dilution, in the cold, and successive fractions, usually ten per tube, were pipetted off during the day for insemination of cows, the later fractions, frequently used after the tube had been standing for several hours, would naturally contain a preponderance of the sedimented X-chromosome-rich sperm.

After many discouragements he was permitted to work on rabbits at the Max Planck Institute for Animal Husbandry at Mariensee, West Germany. Using suitable dilutions of rabbit semen for A.I., he was able to show that 83 per cent male offspring resulted from use of the top layers of the tube, 55 per cent males from the middle layers and only 26 per cent males from the lower layers. There is need for further study to establish optimum conditions for other animal species, especially for cattle, among which the economic repercussions of such sex regulation would be very great. At last, after ten years, Dr. Bhattacharya has received the necessary encouragement, and is now engaged in a two-year project with cattle, at

Cambridge. At the end of this period, it is hoped that some conclusions can be drawn regarding the practical applications of this work.[1]

While, recently, this work has aroused interest in other countries, and also in the F.A.O., it may be superfluous to add that as usual, the authorities in India—the country which is in great need of these studies—evinced no interest in this work and made no effort to give any encouragement or facilities for the continuance of this study.

40A, Ridge Road,
Bombay 6,
November 11, 1964.

A. N. D. NANAVATI

5. WINTER FOOD OF THE PAINTED PARTRIDGE [*FRANCOLINUS PICTUS* (JARDINE & SELBY)] IN RAJASTHAN[2]

Since my report about the occurrence of the Painted Partridge, *Francolinus pictus* (Jardine & Selby), in Rajasthan [*Newsletter for Birdwatchers*, 1963, **3** (2) : 4] I was looking for existing literature on its food, and found that practically nothing is known about the plant species, the seeds of which are usually taken by them. In the month of December, I was able to collect and analyse food from the crops of 9 Painted Partridge collected from Bisalpur, near Erinpura, Jodhpur District, Rajasthan. The contents were analysed by two methods: counting every seed (number method) and by measuring their weight.

The table reveals that seeds of *Brachiaria ramosa* are most preferred and they constitute 20·38% food of Painted Partridge in winter. The second preference of food is seeds of *Cucumis callosus* and *Cyperus rotundus.* It is surprising how the partridge is able to dig the *Cyperus* bulbs which are buried about 4 cm. under the hard soil. Next in preference are the seeds of *Tephrosia purpurea, Panicum antidotale, Zizyphus nummularia, Citrullus colocynthis, Tephrosia uniflora,* and *Cucumis prophetarum.*

It is interesting to compare the frequency of occurrence of the plants in nature, and that of seeds in partridge food. In nature the

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[1] Bhattacharya, B. C. (1964): Prearranging the sex of offspring. *New Scientist* **24** : 151-152.

Anon. (1964): Sex determination. *Family Planning* **13** : 66-68.

[2] Communicated by Dr. Ishwar Prakash, Animal Ecologist, Central Arid Zone Research Institute, Government of India, Jodhpur.

dominant species of plants in winter are *Aristida* spp. 50·89%, *Dicanthium annulatum* 18·56%, *Cymbopogon* 14·96%, *Eremopogon*

TABLE SHOWING THE FREQUENCY OF SEEDS IN CROPS OF PAINTED PARTRIDGE AS COMPARED TO PLANT SPECIES FOUND IN NATURE

S. No.	Species	Number	% Frequency in food	Wt. gm.	Total % of food (by wt.)	% of plant in nature
	Seeds :					
1.	*Zizyphus nummularia*	48	0·8	2·0	5·58	0·5
2.	*Cucumis callosus*	1448	24·5	4·6	12·85	2·0
3.	*Cucumis prophetarum*	208	3·4	1·8	5·02	(during monsoon)
4.	*Cyperus rotundus*	220	3·5	4·6	12·85	0·1
5.	*Cyperus* sp.	85	1·07	1·4	3·91	..
6.	*Tephrosia purpurea*	443	7·35	4·2	11·66	2·3 to 4·5
7.	*Tephrosia uniflora* subsp. *petrosa*	138	2·30	2·0	5·58	
8.	*Solanum albicaule*	104	1·7	0·6	1·60	<0·1
9.	*Pentatropis spiralis*	70	1·1	0·7	1·95	<0·1
10.	*Mukia maderaspatana*	25	0·4	0·7	1·95	<0·5
11.	*Panicum antidotale*	635	10·5	2·1	5·80	..
12.	*Citrullus colocynthis*	48	0·8	2·0	5·58	2·0 (in winter)
13.	*Phaseolus mungo*	34	0·6	1·5	4·10	..
14.	*Brachiaria ramosa*	2481	41·0	7·3	20·38	<0·5
	Insects :					
1.	Large ants, *Monomorium indicum*	23	0·38	0·3	0·80	..
2.	Lady-bird beetles	2	0·03	..	..	..
	14 Plant species; 2 Insect species	6648	99·43	35·8	99·61	..

6·5%, (all grasses). When we turn to the menu of Painted Partridge, it is found that none of the plant species consumed exceeds 4·5% of natural vegetation, rather most of the plant species preferred by the

Painted Partridge are below 0·5% of the natural vegetation. It also shows how selective the Painted Partridge is in its feeding habits. Therefore, its food is not governed by the availability of certain plant species which occur in large number, but it searches and selects its favoured food, which may be only 0·1% of the natural vegetation. This is also the case with insect food. The orthoptera represent by far the greater majority of insects at Bisalpur but the Painted Partridge eats large ants, *Monomorium indicum*, and small lady-bird beetles.

DEPARTMENT OF ZOOLOGY,
UNIVERSITY OF JODHPUR, S. C. SHARMA
JODHPUR, RAJASTHAN,
June 19, 1963.

6. THE JUNGLE BUSH QUAIL [*PERDICULA ASIATICA* (LATHAM)] : A NEW RACE FROM SOUTH INDIA

In 1963, the Virus Research Centre's field station at Vellore, North Arcot District, Madras, sent some birds to the Bombay Natural History Society for identification. A Jungle Bush Quail [*Perdicula asiatica* (Latham)] appeared to differ from those in the Society's collection by the throat being a dark chocolate-brown as against various shades of chestnut in birds from other areas. H.A. suggested that, with a few more specimens, it might be possible to determine whether this was only an individual variation or represented a different race in that area. In February 1964, R.R. obtained eight more specimens. An examination of the 78 skins now available in Bombay does not support the position outlined in the SYNOPSIS, where Ripley accepts three races from India:

Perdicula asiatica asiatica (Latham) (Type loc.: Mahratta region). In Rajasthan, Bombay, Madhya Pradesh, Bihar, West Bengal, Orissa, and south through Andhra to Madras and Mysore.

Perdicula asiatica punjaubi Whistler (Ambala, Punjab). In Kashmir, East Punjab, Himachal Pradesh, Delhi, and Uttar Pradesh.

Perdicula asiatica vidali Whistler & Kinnear (Kelsi, South Konkan). In Malabar Coast through Kerala.

Our examination prompts the following remarks:

Perdicula asiatica asiatica

In *J. Bombay nat. Hist. Soc.* **38** : 385, Whistler restricted the type locality to Poona, whence we have 3 ♂♂ and 1 ♀. Unfortunately they have clipped wings indicating that they were purchased from trappers, but it is unlikely that they were brought over any great distance.

Both the males and the female are dark reddish brown above with none of the cream-coloured shaft stripes on the upper surface. The few marks both dark and pale are blotches rather than longitudinal streaks. Specimens from Khandala, the Bombay Konkan, and a female from Dedipada, Rajpipla, Gujarat, may be included in this form.

The single female from Poona and two from Panchgani are more chestnut below, the colour of the abdomen and breast almost merging into the chestnut of the chin. The other females of *asiatica* and the other races have the underparts of various shades of vinous brown, but with the chin always of a distinctly different colour. Juveniles from north Konkan have the upper parts more prominently streaked.

Perdicula asiatica punjaubi

A pair from Kaira and a ♀ from Danta, Mahi Kanta, both in north Gujarat, are paler, with no trace of reddish brown in the upper plumage, and have the upper parts more strongly marked with distinct pale shaft stripes as in the grey quails (*Coturnix*) and fewer markings on the nape. Birds from Baghat State, Simla Hills, NW. Himalayas, are very similar above with rather darker chins though not as dark as those of the new form described below.

Perdicula asiatica vidali

There is only one old and badly damaged specimen from Ratnagiri, South Konkan, available for examination. The original description states that both adults and immature birds differ from the typical race in the deep reddish tint of the whole upper plumage, a character which is more particularly marked on the crown. The black barring of the lower plumage was also said to be broader than in the typical form. Apart from the series from South Konkan, Whistler & Kinnear only saw one more skin from Malappuram, in Malabar District, now in Kerala State, and specifically stated that the three Nilgiri specimens from the northern face of Seagore (?) 'do not of course belong to it'. Sálim Ali obtained no specimen in Travancore and Cochin, and we do not know if the range as in the SYNOPSIS is warranted.

A pair from Chandgod, Belgaum District, and two birds from Salsette Island have their foreheads strongly washed with red and are probably close to this form.

Perdicula asiatica subsp. nov.

The eight new specimens (6 ♂♂ and 2 ♀♀) were obtained by R.R. from gypsies who had trapped them in the Government Reserved Forest about 25 miles south-west of Vellore, North Arcot District,

Madras. As they had their wing-feathers clipped and were not in very good condition, they were retained alive for some time and, in June 1964, were sent to Bombay.

All the nine birds, both males and females, have consistently dark chocolate-brown chins and can be picked out from among the others. They are paler than typical *asiatica*, with no trace of reddish wash on the upper parts. The pale streak markings are also stronger, though not as heavy as in *punjaubi*. It has not been possible to compare them with specimens of *P. a. ceylonensis*, which is illustrated in Henry's BIRDS OF CEYLON with a dark chocolate chin. However, the type description of *ceylonensis* states that 'the upper plumage of both sexes is much darker throughout, with the black blotching and pale shaft-streaks of the scapulars reduced in extent so that these parts do not contrast so strongly with the rest of the plumage as in the typical race'. Thus it does not seem likely that we are dealing with *ceylonensis* at Vellore.

We, therefore, select a male obtained on 13 November 1963 near Vellore, bearing Virus Research Centre No. R.R. 1080 and Bombay Natural History Society Register No. 21554, as the type and name it:

Perdicula asiatica vellorei subsp. nov.

The absence of sufficient material from the surrounding areas prevents us from defining the limits of distribution of this race.

Whistler (*J. Bombay nat. Hist. Soc.* **41** : 480) referred to the probability of more races in southern India, and there is no doubt that the description of *vellorei* does not complete the work.

We have specimens from Shimoga, Palkonda Hills, Seshachalam Hills, Vijayanagar (Hampi, Bellary), Bina (C.P.), and Gwalior State, which are difficult to name definitely.

The birds from Bina (C.P.) are intermediate in colouring and have dark chins. One female from Palkonda Hills has a dark chin, and so have three males from Shimoga, one of which almost approaches the chocolate of the Vellore birds. These three birds are very distinctive, being the darkest in the collection, a blackish brown, with no trace of red, and very heavily streaked above. The bars on the chest are narrower and closer together than in any other specimen.

There appears to be no difference in wing length between specimens from north and south India.

The sequence of plumages is also not clear, and several specimens in adult female plumage have been reliably sexed as males, while birds with barring on the underparts have been found to be females. Perhaps these irregularities may in some way be linked with their social habits, of which we know nothing; a range of specimens

from over a large area is essential and we hope members will help to secure them.

75, ABDUL REHMAN STREET, BOMBAY 3, HUMAYUN ABDULALI

VIRUS RESEARCH CENTRE FIELD STATION, VELLORE, SOUTH INDIA, RACHEL REUBEN
August 28, 1964.

7. ROOSTING OF THE GREY WAGTAIL [*MOTACILLA CASPICA* (GMELIN)] IN THE THEKKADY WILD LIFE SANCTUARY

A report by Cawkell (1947)[1] is referred to by Dr. Stuart Smith (1950)[2] as describing 'a small tree at Beirut in the Lebanon, that was the winter roosting place of a flock of twenty to thirty Grey Wagtails'. The following note describes a roost at Thekkady where there were 46 Grey Wagtails at least.

Thanks to the United States Information Service, Trivandrum, I was able to spend 3 nights (March 31, April 1st and 2nd, 1964) in the Edapalayam Tourist Bungalow within the Periyar Wild Life Sanctuary, at an altitude of about 3000 ft.

On April 1, at 6.00 hrs. I saw a few slim, long-tailed birds flying from a small Silver Oak (*Grevillea robusta*), alighting on the branches of a larger tree close by, and then flying off. That evening, at 18.5 hrs., Grey Wagtails started arriving in ones and twos. They alighted on the roof, and ran about and preened themselves (giving me excellent opportunities to make sure of the rump colour). Apart from a few subdued *chip-chip* notes, they made little noise and showed very little excitement. A few of them flew into a larger tree (a Rusty Shield Bearer, I think), only to return at once to the roof. Unfortunately, I was called away before I could see them settling down. At 20.00 hrs. I examined the Silver Oak, and the torch-beam revealed eight birds fast asleep. Most of them were quite conspicuous from below, though all of them were well protected from above by leaves. Some sat with body and tail at a 45-degree angle to the ground; others seemed to be more or less resting flat on the leaves of the twigs where they perched. All those that could be seen well had their heads tucked

[1] CAWKELL, E.M. (1947): A winter roost of Grey Wagtail. *Brit. Birds* **40**: 213 (original not seen).
[2] SMITH, S. (1950): THE YELLOW WAGTAIL: 88.

into the back, and they did not make the slightest movement even when the torch-beam was kept steadily on them. The breasts of these birds were less fluffed out than, for instance, are those of sleeping orioles and ioras. The heights at which the birds were sleeping ranged from 12 feet to 25 feet above ground. Of the 8 birds seen only two were close together; the others were sitting widely separated from one another.

On the 2nd April I could not watch the wagtails. But on the 3rd I was under the Silver Oak some 5 minutes before 6.00 a.m. Exactly at 6.00 a wagtail shot off its perch in the Silver Oak and, twisting and turning in characteristic fashion, alighted on the roof. It stayed only for a moment. Then it flew off to the east. From 6.00 a.m. till 6.09 birds kept erupting from the roost-tree in ones and twos, making it easy for us to count them as they flew out. In all I counted 46 wagtails flying out of that tree. (I was absent for a minute or so during this period, examining another Silver Oak growing a few yards away.)

It was seen that there had been birds even on the lowest branches, just 8 feet above the ground. Every twig and branch above that level seemed to have carried its quota of birds.

The birds from the lowest perches were the first to leave, and some of the last came out of the top branches. Most of the birds had been so well hidden that I could have sworn, at 6 a.m., that there were only some 10 birds in the tree. In fact the butler, who had examined the tree by torchlight the previous night, was ready to wager that there were only 2 birds in the tree!

The Silver Oak preferred by the wagtails was a slim tree about 30 feet tall, standing very near the eaves at the angle between the main block and the kitchen, on the northern side. There was a larger Silver Oak on the southern side of the kitchen block, but there was not a single wagtail in it.

Most of the roosting birds left the tree between 6·00 and 6·05.

On the way to Aranya Nivas on the 31st of March I saw a few Grey Wagtails beside the road. At one place, where there was a trickle of water, two wagtails were quarrelling. Their lower plumage had already become bright yellow. Some of the birds seen on the roof on April 1 had grey chins too. Curiously enough I did not notice a single wagtail anywhere in the lake during the 3 hours spent cruising in search of wild animals on the 1st of April.

MAHARAJA'S COLLEGE,
ERNAKULAM, KERALA, K. K. NEELAKANTAN
April 20, 1964.

8. RECOVERY OF RINGED BIRDS

Ring No. and species	Date and place of ringing	Date and place of recovery	Remarks
F-3505 *Anas crecca* ♂	6.2.1964. Manjhaul, (*c*. 25.23 N., 86.30 E.), Monghyr Dist., Bihar, India	15.3.1964. Bernpora, Srinagar, Kashmir, India	Reported by Suram Singh, Srinagar, Kashmir
C-419 *Anas crecca* ♀	19.2.1964. do.	15.9.1964. Near Asino (*c*. 57 N., 86 E.), Reg. Tomsk.	Reported by Bird-Ringing Centre, USSR
C-2091 *Anas crecca* ♀	3.2.1964. do.	25.8.1964. Near Tarkhanskoe (50.06 N., 82.57 E.), Kazakhstan	do.
C-171 *Anas crecca* ♀	18.2.1964. do.	7.9.1964. Verkhne-Vilyuysk, District Yakutian (*c*. 63.30 N., 120.15 E.)	do.
F-3567 *Anas clypeata* ♀	16.3.1964. do.	13.8.1964. Dalyr, Verkhne-Vilyuysk, Dt. Yakutian, USSR (*c*. 63.30 N., 120.15 E.)	do.
E-605555 *Anas acuta* ♂	4.10.1962. Kurgal' dzhin near Tangiz, Tselinograd, Reg. Kazakhstan (*c*. 50.30 N., 69.35 E.)	January 1963. Bhuj, Kutch, India	Reported by Major S. A. Mohite, Poona
E-555204 *Hydroprogne caspia*	1.7.1961. Kazoty-Iace, (*c*. 43.30 N., 70.40 E.), Dzhambul Region, Kazakhstan	3.11.1964. From the Ganges between Sakrigali Ghat, and Manihari Ghat, West Bengal, India	Reported by E. H. Robertson, Bihar
A-11565 *Passer domesticus parkini* ♂	31.3.1962. Bharatpur, Rajasthan, India.	10-11.1964. *c*, 20 km. NE. of Tchimkent (*c*. 42.30 N., 69.50 E.), Kazakhstan	Reported by Bird Ringing Centre, USSR
A-30934 *Motacilla flava thunbergi*	27-1-1963. Edanad, (*c*. 9.20 N., 76.38 E.), Kerala, India	4.5.1964. *c*. 60 km. N. of Chimkent, Kazakhstan	do.
A-39724 *Motacilla flava*	27.9.1963. Bharatpur, Rajasthan (*c*. 27.13 N., 77.32 E.), India	10.5.1964. Goluboka (53.33 N., 74.22 E.), Omsk Region	do.

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD, EDITORS
BOMBAY 6-WB.,
November 30, 1964.

9. EARLY RECOGNITION OF SEX IN THE JUVENILE FORMS OF *SITANA PONTICERIANA* CUVIER

(*With two photographs and a text-figure*)

While conducting field observations of the Fan-throated Lizard, *Sitana ponticeriana* Cuv., I collected many juvenile forms of this species. Detailed study in the laboratory revealed that, though the forms are immature, sexing is possible. The distinguishing characters are enumerated below.

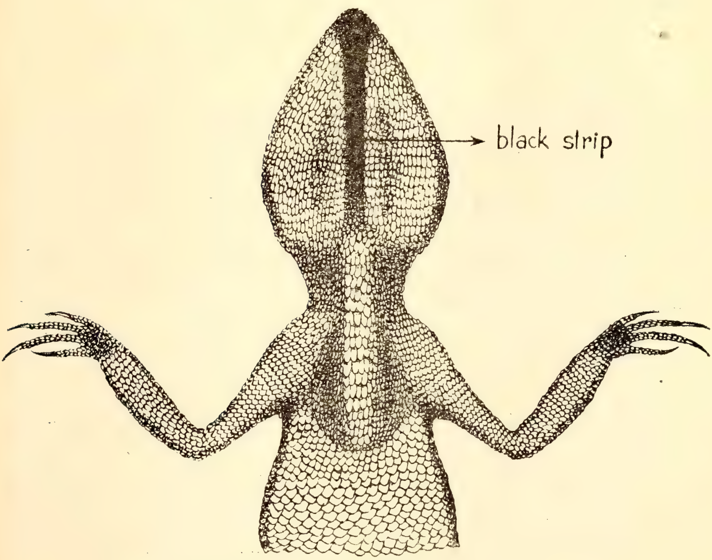
Photo 1. *Sitana ponticeriana* Cuvier

Male with its gular appendage distended

Sitana show distinct sexual dimorphism. The adult male can be easily recognised in the field by its multi-coloured gular appendage (Photograph No. 1).

Photo 2. *Sitana ponticeriana* Cuvier

Figs. 1-4. Juvenile forms arranged according to the development of the gular appendage. Fig. 5. Adult



Text-figure. *Sitana ponticeriana* Cuvier

Ventral view, showing black strip

The specimens studied were collected from hills around Poona, namely Chatursbingi and Vetal Hills, during April, May, and June 1964. After killing with chloroform, they were arranged in the dissecting dish according to the degree of development of the gular appendage as shown in Photograph No. 2. This showed that the earlier stage is one where there is a beginning of the development of a black strip along the mid-ventral line of the lower jaw. This black strip in further stages goes on increasing posteriorly and simultaneously broadens as well. The text-figure shows the black strip. This conclusion was confirmed by dissecting the juvenile forms and ascertaining the presence of testes and hemipenes in well-developed condition.

It is not possible at this stage to give accurate information regarding the development of the gular appendage. This is only possible after rearing the young right from the egg stage in the laboratory, when the development of the gular appendage corresponding to the age, and the length of the individual can be correlated. This work has been taken in hand.

ZOOLOGICAL SURVEY OF INDIA,
WESTERN REGIONAL STATION, R. N. CHOPRA
POONA 5,
July 6, 1964.

10. ACCIDENTAL DEATH OF THE CHEQUERED KEELBACK [*NATRIX PISCATOR* (SCHNEIDER)]

While out at Lake Beale, Nasik District, Maharashtra, on 30 December 1963, I saw a largish snake, dead and floating limply near the surface of the water. The prominent black and white markings indicated a Chequered Keelback (*Natrix piscator*), but one end was uniformly flesh-coloured and prompted a closer examination.

The pale end was found to be the rear half of a 20 in. eel (*Mustacembalus armatus*) locally known as Vambat, projecting from the fully distended mouth and foreparts of the 45 in. snake who had obviously over-estimated his swallowing capacity. The snout of the eel was noticeably red.

MESSRS. FAIZ & CO.,
75, ABDUL REHMAN STREET, HUMAYUN ABDULALI
BOMBAY 3,
January 6, 1964.

1. *Ichthyophis beddomii* Peters—male

2. Favoured habitat of *Ichthyophis beddomii* Peters

Photos : B. K. Tikader & P. J. Kulkarni

Ichthyophis beddomii Peters—female, with eggs

Photo : B. K. Tikader & P. J. Kulkarni

11. OBSERVATIONS ON THE CAECILIAN *ICHTHYOPHIS BEDDOMII* PETERS FROM KOTEGEHAR, DISTRICT CHIKMAGALUR, MYSORE

(*With two plates*)

During a faunistic survey tour in Mysore State, in January 1964, I collected several specimens of the limbless amphibian *Ichthyophis beddomii* Peters at Kotegehar, Chikmagalur District. The animal (locally known as *hitalmundi*) lives in mud, near perennial springs (Plate I, fig. 2), but in the rainy season is found abundantly inside the cardamom plantations in and around Kotegehar village. I collected a female coiled round a cluster of eggs which she carried with her in this manner while moving slowly from place to place (Plate II). The eggs were twelve in number and yellowish white in colour. The female specimen was of a fairly big size being 22 cm. in length. The males were generally smaller in size than the females and averaged 12 cm. (Plate I, fig. 1).

I have collected several specimens of this caecilian and have observed that a particular species of eel, namely *Fluta alba* (Zview), is always associated with it. Superficially, this eel looks like a caecilian.

I am thankful to Shri P. N. Krishnamurthy, school teacher and postmaster of Kotegehar village, for help. I am also thankful to Dr. A. G. K. Menon, Zoological Survey of India, Calcutta, for kindly identifying the eel.

ZOOLOGICAL SURVEY OF INDIA,
WESTERN REGIONAL STATION,
POONA 5,
July 13, 1964.

B. K. TIKADER

12. EXISTING FISHERY OF ALIGARH

(*With a text-figure*)

The fish resources of Aligarh and neighbouring areas, potentially rich as they are, yield a mere fraction of what they could were they exploited in scientific fashion. Lack of scientific information, old fashioned techniques of fishing, and the depressed condition of the fishermen lead to a very modest fish output.

The fishery of this region is entirely based on the capture of natural fish populations. With the exception of the University Fish Farm where the Fisheries Section of the Department of Zoology started the culture of major carps on an experimental basis a few years ago, there is no other water area in this district where fish culture is being practised. So far no effort has been made by the State Government to develop and exploit any other water area. In 1958 the Department of Zoology of the Aligarh University for the first time stocked nearly 75,000 fingerlings of major carps in a moat which encircles the ruins of an old fort. The total area of this moat is about 30 acres. Further stockings were made in the moat during subsequent years and, up to 1961, a total of over two lakhs (two hundred thousand) fingerlings has been stocked. The so-called moat has now become the University Fish Farm, and during 1960 and 1961 nearly 300 maunds of fishes were hauled from the farm. This has given a net income of Rs. 4000 to the University. As fish farming in the University moat is being practised on an experimental basis mainly to raise material for research and there is no economic purpose attached to it, the yield obtained shows the potentialities of fish culture in this part of the country.

The bulk of fish landing in Aligarh comes from the rivers Ganga, Jamuna, Kali, and a lake called Naujheel. The major portion of the fish landing is constituted of major carps, cat-fishes, and murrels. The following species of each group form a regular fishery:

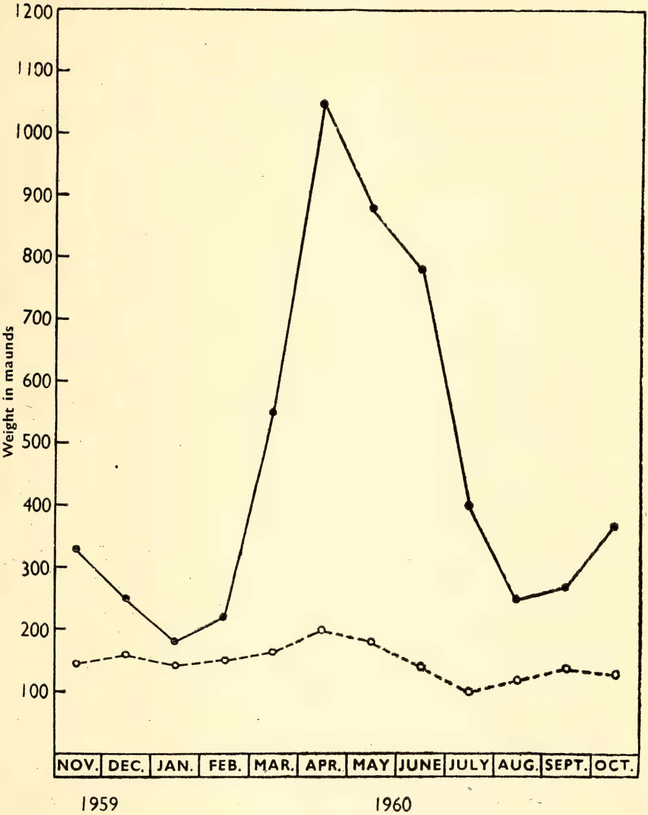
Major carps:	1. *Labeo rohita* (Ham.)
	2. *Cirrhina mrigala* (Ham.)
	3. *Catla catla* (Ham.)
Cat-fishes:	1. *Mystus seenghala* (Sykes)
	2. *Mystus bleekeri* (Day)
	3. *Wallagonia attu* (Bloch)
	4. *Callichrous bimaculatus* (Bloch)
	5. *Callichrous pabda* Ham.
	6. *Bagarius bagarius* (Ham.)
	7. *Eutropiichthys vacha* (Ham.)
Murrels:	1. *Ophicephalus punctus* Bloch
	2. *Ophicephalus striatus* Bloch
	3. *Ophicephalus marulius* Ham.
Mullet:	1. *Mugil corsula* Ham.

In addition to these species there is a seasonal fishery of the mahseer [*Barbus* (*Tor*) *putitora*] during winter months (December-April). Most of the mahseer catches come from the River Ganga. In some months the catches are heavy and roughly amount to 20-50

maunds a day. From Aligarh this fish is mostly exported to Calcutta. *Notopterus notopterus* and *N. chitala* also form a seasonal fishery after the monsoons. But the catches of these two species are never heavy.

The ways in which fish exploitation occurs in Aligarh are as follows:

Ponds and lakes of a given area are either given to a fish contractor



Fish landing at Aligarh during 1959-60

Export to Calcutta, continuous line ; local consumption, broken line (based on figures obtained from wholesale)

on a royalty basis or are auctioned each year generally to the fishermen. More or less the same conditions apply to rivers, except

that the fishing rights of a given area are sold to the contractors by the Government Irrigation Department. Normally these contractors do the fishing, and the total fish caught each day is transported to the city fish-market where it is auctioned. Usually the wholesale dealers or the fish merchants buy the fish. Then, these fish merchants either sell the fish to the local fishmongers who later on sell it in the city, or pack it in ice and export it to Calcutta where it is supposed to fetch excellent, sometimes fancy, prices.

The figure shows the statistics of fish landing in Aligarh City during a period of twelve months. The figures obtained in various months are based entirely on the data of wholesale dealers. Figures of small catches made by the local fishermen themselves could not be procured for the whole year and whatever data could be obtained for some months have not been included in the statistical analysis. However, from the amount of fish which they receive from the wholesale dealers and the total quantity which they actually sell in the fish-market, it can be assumed that they make a substantial contribution of their own in the local consumption. It can be seen from the figure that the major portion of the fish landing goes to Calcutta. It is partly because Aligarh is on a direct railway line to Calcutta and partly due to the low consumption in the city which leaves a considerable marketable surplus. Maximum catches are recorded during summer months (April-June) when the quantity of water in rivers, lakes, ponds, etc. is at its minimum. High figures during June and July are quite suggestive and give an indication of late monsoons which is a characteristic feature of Aligarh. Local consumption in the city remains more or less stable throughout the year. It is not subjected to a marked rise even when the catches are heavy. The buying capacity of the general public being limited, the fluctuations in the local consumptions are chiefly due to the rise and fall of the price. During summer months when the fish is very abundant, local consumption shows a slight increase. This is because of a drastic fall in the price. Moreover, since fish perishes quickly during summer months and there are no storage facilities, low price becomes an obvious necessity for its immediate disposal.

International Biological Programme,
Indian Ocean Expedition (C.S.I.R.), S. Z. QASIM
Ernakulam, Kerala,

Department of Zoology,
Aligarh Muslim University, A. QAYYUM
Aligarh,
September 9, 1963.

13. SOME INTERESTING METHODS OF FISHING *SPARUS* SPP. 'KHURANTI', IN CHILKA LAKE[1]

Fishing methods of Chilka Lake have been dealt with by Devasundaram (1951, 1954), Jones & Sujansingani (1951, 1952a & b, 1954), Mohapatra (1955a-c), and Mitra & Mohapatra (1957). While engaged in certain fishery investigations is Chilka Lake during the years 1956-1961, the authors observed certain hitherto unrecorded methods of fishing Dhala Khuranti, *Sparus sarba*, and Kala Khuranti, *S. datnia*. These methods, observed in the rather remote and not easily accessible lake mouth region of Chilka Lake, are described in the present note.

1. *Use of blood-dripping chunks of shark flesh.* In this method of capturing *Sparus*, empirically known to local fishermen for generations, advantage is taken of the apparent attraction of this fish to shark flesh and blood. Sharks, generally *Carcharinus* sp., are commonly caught by spearing at the lake mouth region. A freshly captured shark is cut open for the removal of its liver in a boat so that the blood collects in a pool in the bottom of the boat. The carcass is cut into large chunks of flesh and dipped in the pool of blood. These blood-dripping pieces of shark flesh are held by hand or rope submerged in the water at a depth of about 2 ft. at selected spots near the shore and are gently carried or towed to and fro for short distances without creating much disturbance in the water. A few small pieces of shark flesh are also dropped in the water near the man towing the chunk. The oozing blood, for some reason which is not yet fully understood, soon attracts groups of *S. datnia* and *S. sarba*. The *Sparus* is not seen to eat the flesh but, in general, trails behind the 'receding bait'. It is possible that some fish at least nibble at the shark flesh. The man holding the bait, on observing sufficient accumulation of *Sparus* trailing behind it, signals to others waiting near by, who encircle the fish with Khari Jals (a type of hand seine extensively used in Chilka) and haul them up. A number of pieces of shark flesh are used by different sets, each of 6-8 fishermen, or the operation is repeated by the same set in this fashion at different spots,

[1] Published with the permission of the Director, Central Inland Fisheries Research Institute, Barrackpore, W. Bengal.

and 50-60 kg. of *Sparus* are often caught in 2-3 hours by a party. A single operation generally takes about an hour and as many as three operations are made using the same piece of flesh. This method is used during the period November to January, when the Chilka *Sparus* migrates from the lake to the sea for breeding and are generally available in fairly large numbers in the lake mouth region. The flesh of sea turtles is occasionally used as a substitute for shark flesh for this purpose.

2. *Use of black silicaceous earth.* Mounds of black earth (about 3-4·5 m. in diameter and 60-120 cm. high), scattered in the inter-tidal zone of the lake mouth region, are a characteristic feature in certain seasons. At times a tall bamboo pole marks the location of the mound. These mounds are put up by the local fishermen in the inter-tidal zone to attract *Sparus* spp. which, apparently have a liking for the substance the mounds are made of. Groups of *Sparus* gather round the black heaps at high tide and, sensing the congregation from underwater ruffle or perhaps intuitionally (the operations being only nocturnal), the fishermen encircle the mound with Khari Jals and make an easy haul of the catch. Like the method described above, this method is practised during November-January when there is a concentration of *Sparus* spp. in the lake mouth region. About 25-35 kg. of the fish is often caught in one night by this method. The black earth on close inspection shows a conglomeration of dehydrated vegetable matter embedded in black silicaceous earth and it is believed that *Sparus* is attracted by the vegetable matter.

Of special interest is the practice of nocturnal angling by many people for *Sparus* spp. in the lake mouth region during November-January. The shore profile of the region is marked by deposits of black earth, of the type described above, standing in sharp contrast to the adjacent sandy areas. The anglers congregate in the black earth portions of the shore, since a continuation of the black deposit in the contiguous underwater region attracts *Sparus*, especially at nights, enhancing the chances of the fish taking bait, comprising pieces of prawns or algal weeds. The anglers invariably do the fishing very successfully in such situations.

The gut contents of *Sparus sarba* are found to be 31% algae, 20% molluscs, 17% crustacea, 12% decayed organic matter, 11% weeds like *Aalophyla, Potamogeton,* etc., and 9% miscellaneous matter (Jhingran *et al.* 1963). The fish may, therefore, be regarded as omnivorous. As neither blood nor shark flesh nor earth have been

identified in the stomach contents it is possible that the attraction to these baits is due to a chemotactic stimulus.

CHILKA INVESTIGATION UNIT,
CENTRAL INLAND FISHERIES
RESEARCH INSTITUTE,
BALUGAON (PURI), ORISSA,
January 6, 1964.

V. G. JHINGRAN[1]
S. PATNAIK

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14. A NOTE ON THE IDENTITY OF *ONYCHIURUS GRANULOSUS* STACH AND *O. PSEUDOGRANULOSUS* GISIN (COLLEMBOLA : ONYCHIURIDAE)

(With three text-figures)

The controversy relating to *O. granulosus* Stach and *O. pseudogranulosus* Gisin has been left unsettled since Stach (1954) considered the latter species to be identical with the former on the assumption that Gisin's failure to observe the ventral organ in the male specimens of *O. pseudogranulosus* was due to the forms examined being immature—other phenotypic differences between them were considered by Stach to be insignificant. In the light of this disagreement between two pioneer Collembolan taxonomists the present author felt it imperative to undertake this investigation to resolve the controversy.

The descriptions below are an addition to the original findings and are based on some new chaetotactic criteria of the syntypic materials

[1] Present address: Central Inland Fisheries Research Sub-Station, 30-Pannalal Road, Allahabad.

(specimens of *O. granulosus* and *O. pseudogranulosus* were obtained from Prof. Jan Stach of Krakow and Dr. H. Gisin of Geneva respectively).

DESCRIPTION

O. pseudogranulosus

BODY:

Abdomen broadened especially in adult females; Abd. VI distinctly visible in the upper view.

Antennae: Ant. Org. III with 2 straight granulated sense clubs, four finely granulated papillae, 4 setae, and 2 sense rods.

P.A.O. With 7-10 vesicles separated from each other.

Pseudocelli. $\frac{33/133/33333}{1/000\ /1212}$; each subcoxa with 2 pseudocelli; pseudocelli on posterodorsal part of head disposed as in the text-figure 1.

Legs. Unguis untoothed; Unguiculus without basal lamella; relative lengths of Unguis III : Unguiculus III as 21 : 21.

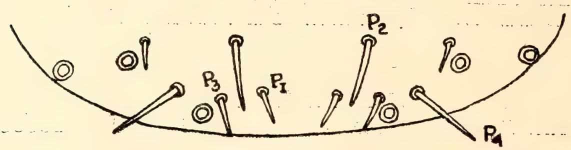

Fig. 1. *Onychiurus pseudogranulosus* Gisin

Posterodorsal part of head

CHAETOTAXY:

I antennal segment. Ventrally with 5 setae as in IV instar of *O. fimatus.*

Anterodorsal part of head. With one median seta A_0 and twelve setae B_2, B_3, B_5, B_7, B_8, C_1, C_2, C_3, C_4, D_1, D_2, and D_3 on either side of it (Text-fig. 2).

Posterodorsal part of head. With 4 setae P_1, P_2, P_3 and P_4 of which P_4 largest and inserted in between inner two pseudocelli, P_2 placed forward of others and much longer than either P_1 or P_3 (Text-fig. 1).

Tergite of Th. I. With 5 setae N_2, N_3, N_4, N_7 and N_9 disposed as in the text-fig. 3.

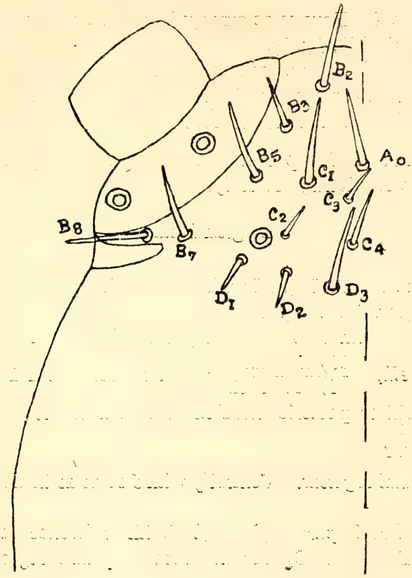

Fig. 2. *Onychiurus pseudogranulosus* Gisin
Anterodorsal part of head

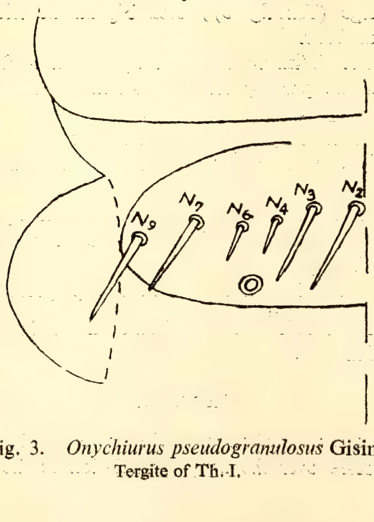

Fig. 3. *Onychiurus pseudogranulosus* Gisin
Tergite of Th. I.

Subcoxa I. Four setae arranged as in *O. moniezi* Bagnall (vide Choudhuri 1963, fig. 8).

Ventral tube. One basal seta; no anterior seta; distally 7 setae (usually) arranged as in *O. imperfectus* (Denis).

Ventral organ in male. Absent.

LOCALITY. 1 Damp rotten wood, Grotte de peyrons, Ariege, France; 2. Switzerland; 3. Italy.

O. granulosus

BODY:

Antennae. Ant. Org. III with two straight granulated sense clubs, 5 finely granulated papillae, 5 setae, and 2 sense rods.

P.A.O. With 8-10 vesicles separated from each other.

Pseudocelli. $\frac{33/133/33323}{1/000/1212}$; each subcoxa with 2 pseudocelli; pseudocelli on posterior head as in the text-fig. 1.

CHAETOTAXY:

I antennal segment. Ventrally with 5 setae as in *O. pseudogranulosus.*

Anterodorsal part of head. With reference to the text-fig. 2 seta labelled as C_4 absent; setae C_1 and A_0 of equal size; and seta C_3 smallest.

Posterodorsal part of head. As in *O. pseudogranulosus.*

Tergite of Th. I. Usually one row of six setae of which 4 equally large (Text-fig. 3); seta N_6 an addition to those of *O. pseudogranulosus.*

Subcoxa I. With five setae arranged as in *O. fimatus* Gisin.

Dorsomedian part of Abd. II. As in *O. richardsi* Choudhuri, 1958a.

Ventral tube. As in *O. pseudogranulosus.*

Ventral organ in male. Present and as illustrated by Stach (1954).

Upper anal valve. Setal arrangement on upper surface as in *O. parthenogeneticus* (Choudhuri 1958b); outer semicircular margin as in *O. fimatus.*

All other chaetotactic characters as in *O. imperfectus.*

LOCALITY. Needle litter, Tatra mountain (1350 m. alt.), Skorusniak, Poland.

DISCUSSION

From the above description it will be noted that in many characters such as blunt setae over the body, granulation of the cuticle, general

shape of the body, and the pseudocelli all over the body except that on the tergite of Abd. V, these two species are in complete agreement. Nevertheless, they can be distinguished from each other by at least 5 reliable characters as follows:

	O. granulosus	*O. pseudogranulosus*
1.	Seta C_4 over anterodorsal part of head absent	Seta C_4 over anterodorsal part of head present
2.	Subcoxa I with 5 setae	Subcoxa I with 4 setae
3.	Ant. Org. III with 5 papillae and 5 setae	Ant. Org. III with 4 papillae and 4 setae
4.	Tergite of Abd. V with 2+2 pseudocelli	Tergite of Abd. V with 3+3 pseudocelli
5.	Presence of characteristic ventral organ in male	No ventral organ in male

On examining several full-grown male individuals collected from different localities, the author has failed to find the ventral organ in any of them. As such the objection, raised by Stach (1954), as to the failure of Gisin to notice the ventral organ owing to his materials being immature cannot be upheld. Moreover, leaving aside the differences in the structure of the Ant. Org. III and the pseudocelli on the tergite of Abd. V, which in the opinion of Stach are of no significance due to their variable nature, the other three points of disagreement are convincing enough to separate these two species. Evidently *O. pseudogranulosus* is a valid species, and any attempt to synonymise it with *O. granulosus* is erroneous.

ACKNOWLEDGEMENTS

The author expresses his deep gratitude to Dr. H. Gisin of Geneva and Prof. Jan Stach of Poland for providing him with the materials used in this study.

ENTOMOLOGICAL LABORATORY,
UNIVERSITY OF KALYANI,
WEST BENGAL,
December 13, 1963.

D. K. CHOUDHURI

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15. DORMITORIES OF *CHALYBION BENGALENSE* DAHLB. (HYMENOPTERA : SPHECIDAE)

Several wasps of both sexes of the common domestic species *Chalybion bengalense* Dahlb. were observed to gather in a small lavatory at Unit 5, Type VIII, No. 2, Bhubaneswar, in the afternoon. This lavatory is in a courtyard and separated from other rooms in the house. In the evening, these wasps settled on the hanging chain of a cistern, where they spent the night. They also settled on this chain during the day if it was cloudy or raining. The chain hangs freely, and is composed of 16 links each about 3·7 cm. long, in the form of a figure of 8, with one loop of the 8 in a plane perpendicular to that of the other, each loop being about 8 mm. broad. At the bottom of the chain is a handle connected to the chain by an S-shaped piece. The top of the chain is connected to the shaft, also by an S-shaped link. The bottom of the handle is 136 cm. above the floor of the lavatory and the top of the chain about 2 m. above the floor and 44 cm. below the ceiling. Observations were begun on 18.x.1963. The date and time of each observation with the number of wasps present and their positions (when noted) is given below. The links are counted from below:

Sunrise and sunset timings for this period were about 05·50 and 17·15 respectively.

From the above observations, it is seen that up to 15 wasps spent the night on this chain, this number gradually decreasing till no wasp was seen on the chain after 5.xi.1963. This species, like some others in this part of India, disappears during the winter. Eggs laid after about September spend the winter as diapausing final instar larvae, some of them completing their metamorphosis in about February, but most of them doing so in about May (Jayakar & Spurway 1964).

The wasps also collected on this chain when the weather was not suitable for their activities outside.

When they came to spend the night in clear weather, however, the earliest a wasp was recorded was 15·34 (on 20.x.1963) and the latest

DATE	TIME	NO. OF WASPS	POSITION
18/x	17·06	about 10	flying around chain
	21·36	15	on chain
19/x	08·51	0	
	09·39	0	
	13·33	0	
	16·34	12	10 on chain, 2 on cistern (1 just arrived)—some activity
	18·17	15	4th, 5th, 6th links
20/x	15·07	0	
	15·34	2	1 on cistern, 1 on 8th link
	17·45	7	4th and 5th links
21/x	07·22	1	on cistern
	*12·55	0	
	*12·56	1	on chain
	*12·57	2	on chain
	*12·58	4	on chain
	**12·59	5	on chain
	**13·02	5	4th and 5th links
	**13·35	5	3rd to 6th links
	15·16	6	3rd to 8th links
	17·49	8	3rd to 6th links
22/x	*07·40	3	1 on 7th link, 1 on 11th link, and 1 on pipe below cistern
	**09·19	0	
	**13·20	0	
	17·45	9	3rd to 10th links
24/x	*17·15	0	
	17·47	0	
25/x	09·04	0	
27/x	17·16	1	9th link
	17·43	2	6th and 9th links
	21·53	2	6th and 9th links
29/x	22·05	3	1 on 3rd link, 2 on 5th
30/x	20·37	1	5th link
31/x	06·50	1	5th link
	18.59	1	8th link
1/xi	06·50	0	
	17·27	2	6th and 7th links
2/xi	06·40	2	4th and 6th links
	20·07	2	5th and 8th links
3/xi	16·37	1	5th link
4/xi	19·53	1	5th link
5/xi	08·10	0	
	18·53	2	1 on 5th and 6th links; 1 on 8th link
6/xi	18·08	0	
7/xi	17·51	0	
8/xi	17·46	0	

* indicates cloudy weather.
** indicates rain.

time which the data provide for the arrival of a wasp is 17·16 (on 27.x). The latest a wasp was seen on the chain in the morning on a clear day was 06·50 (on 31.x).

The data for 21.x show the arrival of wasps just as rain was about to start, but more wasps had arrived by the evening so that not all members of the aggregate were able to get back to the roost for the period of rain.

The wasps collected together on a small part of the chain (centred round the 5th and 6th links) rather than distribute themselves over the whole chain. For instance, on 19.x, 15 wasps occupied a part of the chain about 11 cm. long, and on 10.x, 7 wasps were all found on length of chain about 7·5 cm. long. The male of this species is statistically smaller than the female, but there is considerable overlap, so that the numbers of the two sexes present could not be counted separately.

The wasps always clung to the chain in a vertical position, always facing upwards except once, on 2.xi, when one wasp was seen resting facing vertically downwards.

A larger roost of this species was seen on 18 and 19.ii.1964. This roost contained about 40 individuals of both sexes on disused strips of iron hanging from a ceiling in a badly lit but much used room in a house a few kilometres from the last one. However, as this colony was seen at about 15.00 hours on a clear day, it may have been a hibernating colony, even though individuals flew a few centimetres and settled again.

We have also seen solitary sleeping individuals of this species.

Sleeping aggregates of one or several species of solitary aculeate hymenoptera have been described before mainly on trees or shrubs. Where females spend their nights in or near their nests, sleeping aggregates sometimes consist of only males. However, it is known that *Chalybion bengalense* females do not spend the night in the immediate vicinity of their nests.

There are known to be wide variations in the sleeping posture between related species. Rau & Rau (quoted by Wynne-Edwards 1962, p. 309) described two colonies of the related *Chalybion caeruleum* (Johansson and Linnaeus) [now *californicum* (Saussure)] but their colonies were both on the under sides of horizontal surfaces, one of them consisting of about 30 individuals of both sexes. We do not know of other reports of *Chalybion bengalense* dormitories.

Evans & Linsley (1960) have discussed, very briefly, the advantages that may be gained from sleeping in such aggregates, and the stimuli responsible. They suggested that such aggregates may provide protection from predators. But, on the contrary, it seems to us that such aggregation would make them more vulnerable to predators. Lowther (1949, p. 27) and Moore (quoted by Wynne-Edwards 1962, p. 301)

have described bird roosts where predators collected every evening to prey on individuals at the roost and leaving it respectively. However, we do not know of similar observations on wasp roosts. Linsley (quoted by Evans & Linsley 1960) had previously described a sleeping aggregate composed of both host and parasitic species.

Wynne-Edwards's (1962) explanation seems to us more plausible. He suggests that such roosts serve an epideictic purpose, i.e. they provide for the members of a species occupying a certain area an 'estimate' of the population density and thus help in their dispersion. However, mixed roosts of more than one species would not serve this purpose. It may be significant to quote here from Evans & Linsley (1960): 'Such aggregations [of hymenoptera] may be dense and ball-like, or they may be loose, with the individuals sharing the same sleeping site but not maintaining physical contact. The dense aggregations usually consist of a single species. . . . . . By contrast, loose aggregations may be of diverse composition, involving bees and wasps of a number of different families.' The members of the roosts described by us tended to minimise the space that they occupied. Wynne-Edwards (1962) refers to many other similar observations including the Raus's observations on another solitary wasp, *Elis quinquecincta*, where the dormitories consisted entirely of males. This, Wynne-Edwards believes, strongly supports his theory. However, in the hymenoptera, where the males are haploid, the sex-ratio can be very far from equality and the male population may not provide a relevant 'estimate' of population density. It is, therefore, still far from clear why mixed roosts of birds and hymenoptera are so common.

GENETICS AND BIOMETRY LABORATORY,
GOVERNMENT OF ORISSA,
BHUBANESWAR 3, ORISSA,
June 10, 1964.

S. D. JAYAKAR
R. SHASTRY MANGIPUDI

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16. RELATIVE ABUNDANCE OF HOUSEFLIES IN INDIA AND THEIR SUSCEPTIBILITY TO DDT, BHC, AND DIELDRIN[1]

A study of the relative abundance of various species of houseflies in different parts of India is extremely desirable from the standpoint of control and to find out if any species concerned with the transmission of disease has developed increased tolerance to insecticides. Hence, the present survey of the relative occurrence of the more important forms *Musca domestica nebulo, Musca domestica vicina,* and *Musca sorbens* in different states of India and the susceptibility of the predominant housefly, *M. d. nebulo,* to DDT, BHC, and dieldrin.

The flies were collected from bazaars at different places and brought to Aligarh for making population counts. At each place, the flies were collected three times a day, the duration of each period of collection being 30 minutes. Eggs obtained from such flies were placed in glass jars containing moist cotton and the larvae were reared on cotton pads soaked in diluted milk and sugar to produce adult progeny. Four-day-old flies belonging to the form *nebulo* were tested with topical applications of 0·1% solutions of DDT, BHC, and dieldrin. Mortality counts were made after 24 hours of treatment and the results obtained are presented in the accompanying Table.

The following results were obtained:

1. *Musca domestica nebulo* is the most common form of housefly, comprising more than 50% of the fly population at most of the places surveyed. It is abundant particularly in Andhra Pradesh, Bihar, Delhi, Gujarat, Rajasthan, and parts of Uttar Pradesh.
2. The population of *M. d. vicina* tends to increase with increase in altitude, so much so that at Dalhousie in Panjab, Simla in Himachal Pradesh, Chakrata and Mussoorie in Uttar Pradesh, it is far more abundant than *nebulo. vicina* is the predominant form of housefly in Bengal.
3. *Musca sorbens* is essentially a fly of the plains, being entirely absent at higher elevations. It is very common in Panjab and forms as much as 78% of the fly population in Chandigarh.
4. *Musca domestica nebulo* can be effectively controlled by chlorinated hydrocarbon insecticides. It was found to be susceptible

[1] The authors wish to express their sincerest gratitude to the authorities of the National Institute of Health, U.S.A., and to Dr. A. W. A. Brown and Dr. M. A. Basir for their assistance and guidance during the progress of this work.

TABLE

RELATIVE ABUNDANCE AND SUSCEPTIBILITY LEVELS OF HOUSEFLIES *Musca domestica* IN INDIA

State	Place	Altitude* in metres	No. of flies collecte	Percentage abundance			% mortality of *M. d. nebulo* with 0·1% solution of insecticide		
				M.d. nebulo	*M.d. vicina*	*M.d. sorbens*	DDT	BHC	Dieldrin
Andhra Pradesh ..	Hyderabad ..	542	1750	83·1	14·6	2·3	61·3	85·0	78·3
Bengal ..	Calcutta ..	6·5	5700	25·2	69·3	5·5	64·0	93·7	80·0
Bihar ..	Patna ..	53	1830	92·2	1·6	5·4	83·3	100·0	100·0
	Muzzafarpur ..	53	2030	93·5	2·4	3·8	79·3	100·0	82·6
	Bhagalpur ..	49	315	87·3	4·7	7·9	64·8	100·0	78·5
	Katihar ..	32	460	66·3	33·0	0·6	73·0	100·0	76·9
	Siwan ..	77	1440	55·5	44·3	0·0	72·7	100·0	94·1
	Gaya ..	111	2090	81·3	4·6	14·3	71·1	98·2	76·0
	Ranchi ..	655	1625	86·1	3·0	10·7	71·6	100·0	79·5
Delhi ..	Delhi (Old) ..	218	740	76·6	15·0	8·3	43·2	80·3	79·2
	Delhi (New) ..	218	890	73·5	23·03	3·3	37·5	84·0	75·9
Gujarat ..	Jamnagar ..	18	728	75·9	21·1	2·8	45·2	94·1	69·5
	Ahmedabad ..	50	1071	83·0	15·6	1·3	41·3	91·06	72·2
	Baroda ..	35	920	51·2	8·4	40·4	75·3	100·0	85·7
Himachal Pradesh.	Simla ..	2202	350	31·4	68·6	0·0	55·3	87·8	95·0

TABLE—(*contd.*)

State	Place	Altitude* in metres	No. of flies collected	Percentage abundance			% mortality of *M. d. nebulo* with 0·1 % solution of insecticide		
				M.d. nebulo	*M.d. vicina*	*M. d. sorbens*	DDT	BHC	Dieldrin
Madhya Pradesh ..	Bhopal ..	501	3000	59·4	38·3	2·3	50·0	96·2	57·4
Madras ..	Madras ..	15·5	1335	72·3	15·4	12·3	68·1	93·3	81·2
Maharashtra ..	Poona ..	552	749	78·0	7·3	14·7	43·6	59·3	49·3
	Bombay ..	11	2400	63·5	15·1	21·2	45·07	92·0	81·1
Mysore ..	Mysore ..	767·5	537	79·3	17·1	13·6	54·1	80·6	68·7
	Bangalore ..	921	748	61·3	35·5	3·2	65·3	91·5	72·5
Orissa ..	Bhubaneswar ..	30·5	750	60·2	31·6	8·2	71·4	97·4	79·7
	Cuttack ..	26·5	2050	57·2	20·5	22·3	54·4	98·8	69·8
Panjab ..	Ludhiana ..	247·5	1890	59·4	9·3	31·1	68·8	100·0	85·7
	Amritsar ..	230·5	2500	42·3	0·6	57·1	41·5	96·6	76·9
	Jullundhur ..	230	2000	65·6	1·2	33·2	61·8	100·0	86·6
	Pathankot ..	331	200	69·7	30·3	0·0	60·0	100·0	100·0
	Chandigarh ..	378·5	1800	8·7	13·2	78·1	71·1	100·0	88·5
	Dalhousie ..	2145	290	53·4	46·6	0·0	52·8	98·1	100.0

TABLE (*contd.*)

State	Place	Altitude* in metres	No. of flies collected	Percentage abundance			% mortality of *M. d. nebulo* with 0.1% solution of insecticide		
				M.d.nebulo	*M.d. vicina*	*M. d. sorbens*	DDT	BHC	Dieldrin
Rajasthan ..	Ajmer ..	485·5	210	97·1	2·9	0·0	73·07	93·8	87·9
	Jaipur ..	436	460	99·5	0·0	0·5	69·7	95·7	80·5
Uttar Pradesh ..	Varanasi ..	76	832	81·2	9·1	9·6	79·0	97·6	86·6
	Aligarh ..	187·5	533	54·4	36·0	9·5	48·3	82·0	80·0
	Agra ..	168·5	315	67·4	23·2	9·4	74·3	100·0	81·1
	Bareilly ..	173	387	85·7	6·4	7·7	86·5	100·0	100·0
	Rampur ..	188	498	96·4	3·6	0·0	62·2	100·0	100·0
	Saharanpur ..	274	410	38·04	45·3	16·4	65·5	100·0	98·9
	Dehra Dun ..	683	376	35·6	63·8	0·53	48·1	100·0	95·3
	Mussoorie ..	2115	176	45·4	54·5	0·0	57·2	100·0	94·4
	Chakrata ..	2157	208	5·7	94·2	0·0	43·7	98·6	92·0

* Taken from the Survey of India Maps, Calcutta, and the Tables of Observatories in India, New Delhi.

to DDT, BHC, and dieldrin, except at Poona where it showed considerable tolerance to these chemicals. But as no strong tests were made, it is not clear if the increased tolerance of these flies is a case of true resistance and was simply due to the vigour tolerance of the population collected.

5. Of the three chemicals tested, BHC was the most toxic; a concentration of 0·1% of it killed 80·0 to 100·0% of the flies at all places except Poona, where the percentage mortality was only 59·3%.

DEPARTMENT OF ZOOLOGY,
MUSLIM UNIVERSITY,
ALIGARH,
January 1, 1964.

N. H. KHAN
J. A. ANSARI
J. REHMAN
D. AHMAD

17. NEW PLANT RECORDS FROM ERSTWHILE BOMBAY STATE

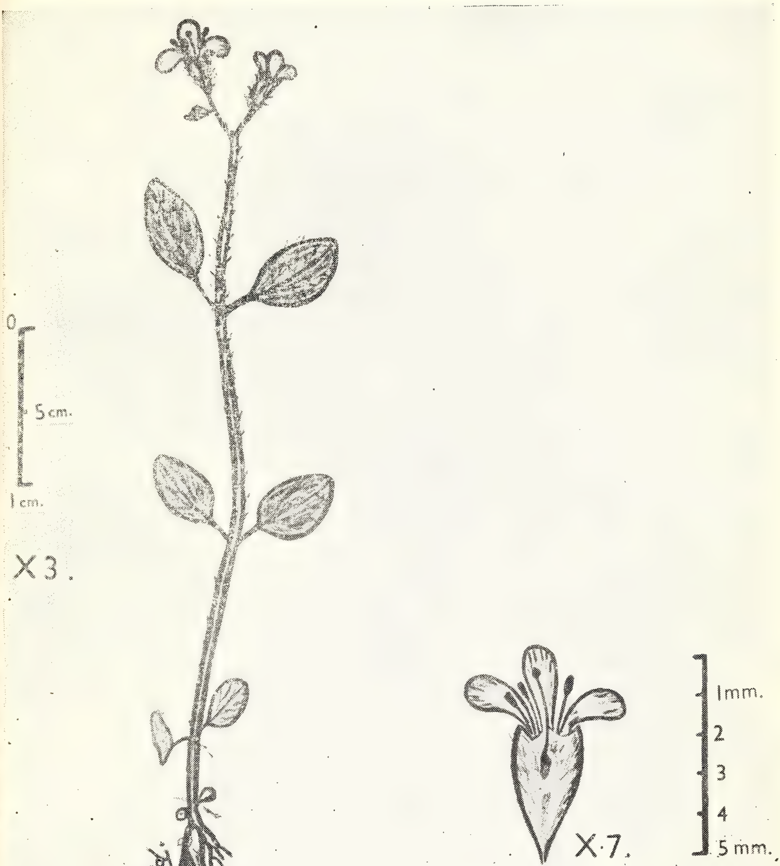
(*With two plates*)

During the course of intensive floristic studies in the Ratan Mahal and surrounding hills, Panch Mahal District, Gujarat State, these plants were collected. After identification, these specimens were checked at F. R. I. Herbarium, Dehra Dun, but in order to remove some minor doubts the specimens were sent to the Royal Botanic Gardens, Kew, for confirming the determination. As far as could be ascertained from the available literature we think that the plants are new records for Bombay State. It is hoped that the illustrations and extensive field notes may help workers on floristic studies in this part of the country to trace the distribution of these plants.

I. **Sonerila tenera** Royle, Illustr. Bot. Himal. 215, t. 45, f. 2 (1839); Hooker, F.B.I. 2:530 (1879).

A small delicate herb. Stem erect, glandular-pilose, slightly winged. Leaves thin, membranous, ovate, entire, less than 1·5 cm. long, with a few scattered lax hairs. Inflorescence scorpioid. Flower small; calyx tube slightly trigonous, with few scattered lax hair. Petals 3, 2×4 mm. ovate acute, rose purple; stamens equal. Capsule about 5 mm. long, trigonous. Seed ovoid, smooth, dark-brown (Plate I).

The plants were found growing in moist dense shady places in the rocks on the way to Patan Mata Hill, Ratan Mahal Hills, Panch



Sonerila tenera Royle

Operculina petaloidea (Choisy) van Ooststr.

Mahal District, Gujarat State. The plant seems to be restricted in distribution: Sub-tropical Western Himalaya (Royle, Edgeworth); Chota Nagpore alt. 1000-2000 ft., abundant (C. B. Clarke); N. Circars, in Ganjam (Gamble); W. Ghats in Wynaad at 4000 ft. on rocks; occasional south to Tinnevelly.

Flowering and fruiting time: August-October.

Herbarium specimens: Nos. *Bedi* 2767, 2768, 2769, 2770.

Critical Notes. Hooker includes this plant among the species not of Ceylon or south Deccan peninsula, but later Gamble records it from Madras Presidency. The specimens collected from Ratan Mahal Hills though much shorter in height (2-8 cm.) tally in all essential details with description mentioned in various Indian floras and specimens housed in the F.R.I. herbarium.

II. **Operculina petaloidea** (Choisy) van Ooststr. in Blumea 3: 369, (1939).

Ipomoea petaloidea (Choisy) in Mem. Soc. Phys. Genèv. 4:451, (1833); Convolv. Or. 69 et in DC. Prodr. IX. 360.

Ipomoea petaloidea Choisy var. *pauciflora* Clarke in Hooker, F.B.I. 4: 212 (1883).

I. xanthantha Kurz, For. Fl. Brit. Burma 2 : 219 (1877).

A large, scandent, glabrous shrub, often found climbing on shrubs or small trees. Stem twisted, grooved and winged at a few places. Leaves 15×10 cm.; base rounded or sub-cordate; apex ovate of the basal leaves, upper leaves acute lanceolate; petiole of the lower leaves about 6 cm. long. Flowers in sub-racemose inflorescence; sepals sub-acute, glabrous; corolla about 3-5 cm. long, yellow with slightly hairy bands outside. Stamens inserted lower down in the tube; anthers sometimes twisted. Capsule 1·5 cm. ovoid; seed minutely velvety.

The plants were found as an undergrowth of a dry, deciduous mixed teak forest, near the bank of a stream on the border of Kanjeta and Mehandri village in Panch Mahal District, Gujarat State. The plant is rare and localised in distribution: N. Oudh, Thomas; all over Prome and Pegu, Kurz. Distribution Timor.

Flowering time: March-May.

Fruiting time: April-June.

Herbarium specimens: Nos. *Bedi* 1965, 1966, 3767, 3768.

Critical Notes. From the examination of Donal's specimens kept at F.R.I. herbarium and the specimens collected from Ratan Mahal it seems that there exists a lot of variability in the leaf and inflorescence character. Basal ovate and upper oblong-lanceolate leaves along

with the peduncles with more than two flowers at the nodes are a common feature of the older branches (Plate II), while all the leaves oblong-lanceolate and peduncles with one or two flowers at the nodes are found on young branches arising from old rootstocks. From these field observations the authors are inclined to believe that *Ipomoea petaloidea* Choisy var. *pauciflora* established by Clarke in F.B.I. is no more valid and should be merged with the species.

ACKNOWLEDGEMENTS

The authors are grateful to Dr. G. Taylor, Director, Royal Botanic Gardens, Kew, England, for confirming the determination of the above-mentioned specimens. Our thanks are also due to Rev. Fr. H. Santapau, Director, Botanical Survey of India, Calcutta, for critically going through the manuscript of this note and making useful suggestions.

DEPARTMENT OF BOTANY,
M.S. UNIVERSITY OF BARODA,
BARODA,
January 11, 1964.

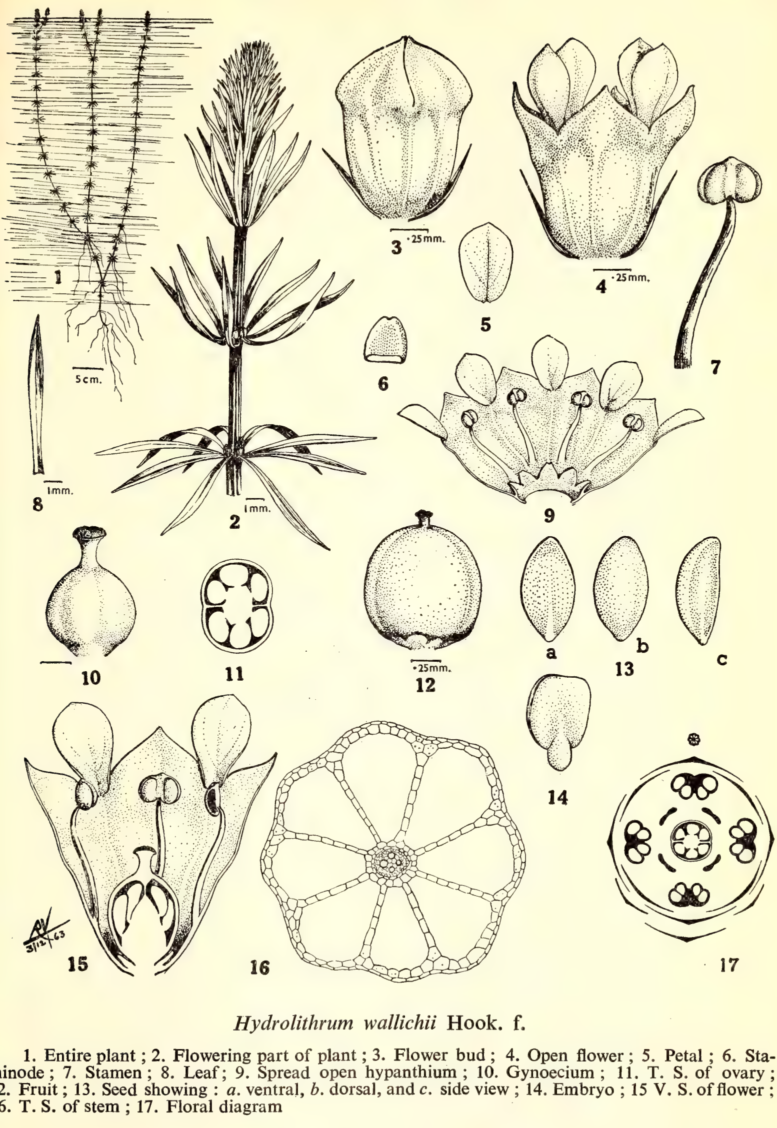
A. R. CHAVAN
S. J. BEDI

18. NEW RECORD FOR *HYDROLITHRUM WALLICHII* HOOK. F. IN SOUTH INDIA

(*With a plate*)

The plant forming the subject of this note was collected from Alwaye, Kerala State, south India, in September 1963. It was found growing in the shallow portion of a freshwater pond along with *Blyxa echinosperma* Hk. f., *Nymphaea nouchali* Burm., *Hydrilla verticillata* Presl., *Rotala rotundifolia* Ham., and *Myriophyllum spathulatum* Blatt. & Hallb. As far as is known to the author this plant has not been recorded from south India. A complete description of the plant based on fresh specimens, is given below.

Habit. Slender, erect, glabrous aquatic herbs with only flowering branch apices emerging out of the water. *Stem* about 1 mm. in diameter and up to 50 cm. long, sparsely branched, of pale pink colour below, and with 8-9 shallow longitudinal furrows. *Leaves* submerged and aerial ones alike in shape and in whorls of 9-12, sessile, exstipulate, narrowing to base, apex acute, midrib narrowly grooved, glabrous,



Hydrolithrum wallichii Hook. f.

1. Entire plant ; 2. Flowering part of plant ; 3. Flower bud ; 4. Open flower ; 5. Petal ; 6. Staminode ; 7. Stamen ; 8. Leaf ; 9. Spread open hypanthium ; 10. Gynoecium ; 11. T. S. of ovary ; 12. Fruit ; 13. Seed showing : *a*. ventral, *b*. dorsal, and *c*. side view ; 14. Embryo ; 15 V. S. of flower ; 16. T. S. of stem ; 17. Floral diagram

about 1 mm. broad and 1 cm. long. *Flowers* about 1·5 mm. long, pink, sessile, solitary in the axil of bractiform leaves towards branch tips, all leaves or only some at a node subtend flowers, bractiform leaves about half the size of vegetative leaves. Flower actinomorphic, hermaphrodite, perigynous, bracteolate; bracteoles 2, lateral, transparent, subulate, more than half the length of hypanthium. *Calyx* 4-lobed, lobes triangular, acute, with rounded corners and without accessory teeth, apiculate in bud, pink, and valvate. *Petals* 4, free, alternating with calyx lobes, attached to inner surface of hypanthium and much exserted, small, obovate, pink, and with one median and 2 lateral veins. *Stamens* 4, free, inserted below the middle of hypanthium, included, alternating with petals, filaments slender, white; anther pink, short and broad, 2-celled and 4-lobed, dorsifixed and introrse; connective prominent, apiculate; staminodes 4, free, small, fleshy, imperfectly bilobed, adnate to the base of hypanthium and alternating with stamens. *Gynoecium* less than 1 mm. long, bicarpellary syncarpous, superior, bilocular with axile placentation; style simple, short, persistent; stigma capitate, minutely papillose; ovules 3-4 in each chamber and anatropous. *Fruit* more than 1 mm. long, much exserted beyond remnants of hypanthium, dehiscing into two valves; seeds 3-4 in a cell, elliptical with concave ventral side; testa smooth, pale brownish yellow when young, deep amber when mature; embryo slightly incurved; cotyledons 2, flat, fleshy, axis short, radicle with rounded apex.

According to Hooker (1878)[1] this species has been recorded from Tavoy and Moulmein but he has not mentioned anything about its distribution in India. The specimens collected from Alwaye, Kerala State, south India, conform to Hooker's description of *Hydrolithrum wallichii* in all essential characters. The presence of the longer stem in the south Indian plants is probably due to the effect of favourable environmental conditions on growth.

The term 'hypanthium' has been used to describe the part referred to as 'calyx tube' by Hooker (1878). Considering the position and adnation to base of the hypanthium, the 'hypogynous scales' have been treated as staminodes in this description.

The author is grateful to Prof. N. A. Erady for his kind encouragement and for making available the necessary facilities.

GOVERNMENT VICTORIA COLLEGE,
PALGHAT, KERALA, R. VASUDEVAN NAIR
December 14, 1963.

[1] Hooker, J. D. (1878): 'Lythraceae' in FLORA OF BRITISH INDIA **2**: 571-572.

19. ON THE OCCURRENCE OF *TRISTANIA BURMANNICA* GRIFF. IN INDIA

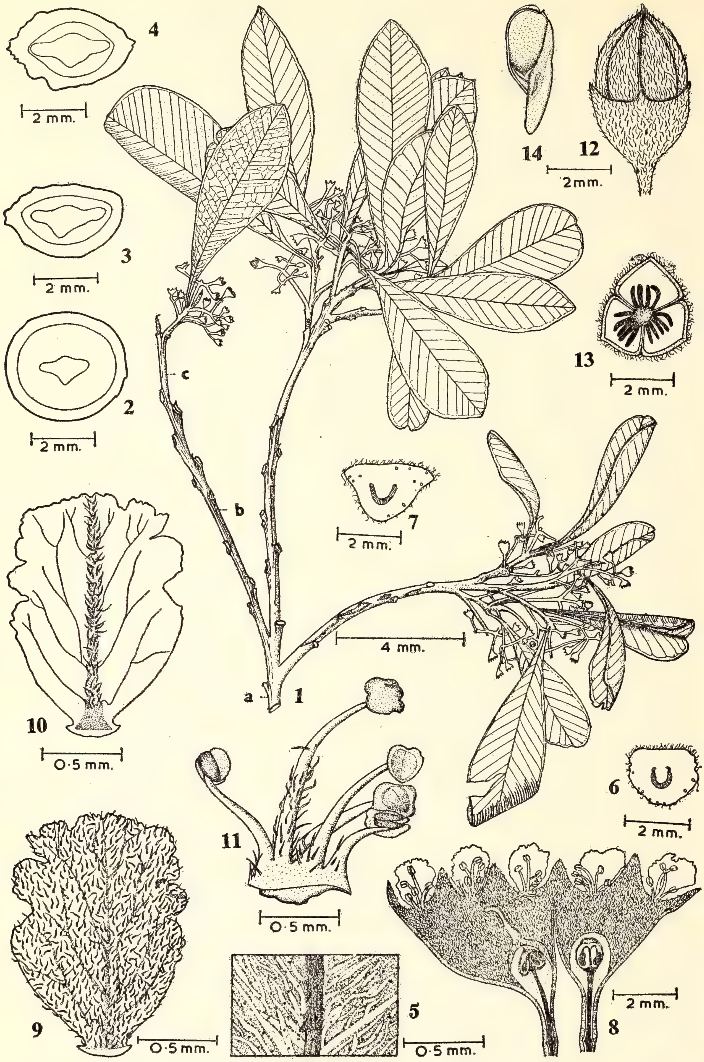
(*With a plate*)

The genus *Tristania* (Myrtaceae) with its 63 species (according to INDEX KEWENSIS, 1895-1959) is distributed mostly in Burma, Malay peninsula and Archipelago, Australia, and New Caledonia. Duthie (1878) in Hooker's FLORA BRIT. IND. has recorded 5 species occurring in Burma or Malaya or both. Of these *T. merguensis* is the only species which Duthie has reported to occur in the Andaman Islands also (but doubtfully, as he mentions 'Tenasserim or Andaman Islands, *Helfer*') though neither Parkinson (1923) nor Thothathri (1960) reports its occurrence there. *T. burmannica* has not so far been reported from anywhere in India proper.

The authors report for the first time the occurrence of *T. burmannica* in India proper from the region of Manipur. The specimens were collected from the hills near Moreh (94·3° N., 24·25° E.), a village situated about 115 km. south-southeast of Imphal, near the India-Burma border and have been compared with the authentic sheets of the Calcutta Herbarium. It is interesting to note that Deb (1961) in his recent work on the flora of Manipur has made no mention of this species whereas our field-book records show that it is common in the neighbourhood of Moreh.

Kurz (1877) reports the occurrence of *T. burmannica* from Burma in the following words: 'Not unfrequent in the Eng-forests along the eastern slopes of the Pegu-Yomah and more frequently from Martaban down to Tenasserim, ascending also the hill Eng and drier hill forests of Martaban up to 3500 ft. elevation.' Duthie mentions it from Tenasserim (*Helfer*), Moulmein and Malacca (*Falconer, Griffith,* and *Wallich*), and Pegu (*Kurz*), observing that it is distributed in Java and Borneo also. However, Koorders (1912) has not included this species in his EXKURSIONSFLORA VON JAVA. While Kurz and Duthie have reported *T. burmannica* from the region of Lower Burma only, Brandis (1906) has completed the broken chain of its distribution by reporting it from the region of Upper Burma also. He, however, has not given the particular localities in Upper Burma whence this species has been collected but its common occurrence at Moreh dispels the doubt if any regarding its distribution in the region of Upper Burma.

Although Kurz and Duthie have both given a detailed description of *T. burmannica* and Brandis has provided a sketch of the flowering



Tristania burmannica Griff.

1. Flowering and fruiting branch ; 2, 3, and 4. T. S. of branches—at *a*, *b*, and *c* respectively ; 5. Upper surface of leaf showing hairs in depression of midrib ; 6 and 7. T. S. of petiole at lower and upper region respectively ; 8. Flower cut open ; 9. Petal—outer face ; 10. Petal—inner face ; 11. Staminal bundle ; 12. Fruit in calyx-cup ; 13. T. S. of fruit ; 14. Seed.

[Figs. 1-11 drawn from LWG sheet No. 49062 (Coll. No. 83105) ; 12-14 from LWG sheet No. 48550 (Coll. No. 83119)]

twig, the authors feel both could be supplemented. Hence a detailed description of the species is given below accompanied by a detailed illustration.

T. burmannica Griff. Cantor Pl. 17. Vernacular names: *taungyo-pyizin*, Lower Burma; *taung-thabye*, Upper Burma.

An evergreen tall shrub or middle-sized tree (20-40 ft. according to Kurz). Branches glabrous, only very young shoots pubescent, bark brownish, peeling off in thin long flakes. Leaves simple, alternate or crowded at the end of the branches, obovate to oblanceolate or oblong-oblanceolate, obtuse or acute or retuse, base cuneate and attenuately narrowed into a pubescent short petiole, $4\text{-}15 \times 1{\cdot}8\text{-}5{\cdot}5$ cm., entire with a slightly revolute margin; midrib impressed above and raised beneath; lateral nerves slender, more or less prominent on both the surfaces, uniting in a continuous looping one near the margin, glossy and glabrous above except in the depression of the midrib where minutely appressedly hairy or glabrescent, pale and glabrous beneath.

Cymes axillary, few-flowered, much shorter than the leaves; bracts linear, minute, hairy, mostly deciduous; pedicels 3-5 mm. long, these and peduncles both angular, hairy. Flowers white, $\pm$ 5 mm. in diameter. Calyx campanulate, shortly five-toothed, $\pm$ 5 mm. long (measured with the teeth), outside pubescent, inside silvery-tomento-villous, teeth $\pm$ 1 mm. long. Petals five, almost rotundate, hairy outside, inside hairy only along the midrib. Staminal bundles five, opposite to petals, 4-7-androus, almost as long as the calyx teeth; stamens free almost to the base, unequal in length; filaments somewhat hairy towards the base or from base up to almost the middle; anthers dorsifixed. Ovary half-superior, hemispherical, silvery-silky-hairy, style nearly glabrous. Capsule almost globose or somewhat ellipsoid, trigonous, $\pm\ 5 \times 4$ mm., nearly pilose or glabrescent, protruding more than half outside the persistent calyx. Seeds more than one in each chamber, compressed, winged in the upper half.

Flowers: March-April; Fruit: April-May.

Sheets represented in the herbarium of National Botanic Gardens, Lucknow: On the hills near village Moreh (near India-Burma border), Manipur State, 610-915 m., 11-4-1962, fl., imm. fr. & fr., *J. G. Srivastava & party* 83105, 'Common tree'; *do. do.* 83114, 'Common shrub'; *do. do.* 83119, 'Common shrub with flowers in Compact cymes'.

The authors are thankful to the Director, Botanical Survey of India for allowing them to consult the sheets of the Calcutta Herbarium and

the Director, National Botanic Gardens, Lucknow, for facilities of work.

NATIONAL BOTANIC GARDENS,
LUCKNOW,
October 10, 1963.

(MRS.) SUMAN CHOPRA
S. L. KAPOOR

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20. THE OPHIOGLOSSUMS OF SALONA-CHIKHALDA ON THE MELGHAT RANGES OF THE SATPURAS

There is no earlier report of Ophioglossums from the Melghat Ranges of the Satpuras, District Amravati, either published or unpublished, although botanists of the district are very familiar with other ferns of the region, e.g. *Aspidopterys, Adiantum, Cheilanthes,* and *Asplenium.* The present note records the occurrence here of as many as four of the ten species available in India. The material, collected during the months of August-September 1963, is preserved and lodged in the personal collections of one of us (R.M.P.). Specific determination is based on the key recently proposed by Mahabale (1962, *Bull. Bot. Surv. India* **4** : 71-84).

All the four species, *Ophioglossum fibrosum* Schum., *O. nudicaule* L., *O. gramineum* Willd., and *O. reticulatum* L., occur at Salona while the first two only are met with at Chikhalda. The last one is also seen at Ghatang about 10 km. from Salona. Of the four species, *O. nudicaule* is the most abundant, *O. reticulatum* and *O. fibrosum* fairly common, and *O. gramineum* rare.

MARATHWADA UNIVERSITY,
AURANGABAD,

VIDARBHA MAHAVIDYALAYA,
AMRAVATI,
October 5, 1964.

R. M. PAI
G. Y. KULKARNI
M. A. DHORE

Notes and News

National Zoological Collections of India

By a recent notification[1], the President of India has been pleased to declare that the Standard Zoological Collections at the Zoological Survey of India will be called the 'National Zoological Collections of India' with immediate effect.

These collections have been built up over a century and include the collections of the former Natural History Section of the Indian Museum, Calcutta, as well as those of the Asiatic Society of Bengal. They contain standard collections, i.e. collections identified by world specialists, and cover all groups of animals such as the Protozoa, sponges, corals and several other marine groups, the molluscs, insects, Crustacea, fishes, reptiles, birds, and mammals, and also include the pre-historic animal remains from various ancient sites in India. These are preserved in a variety of ways, both dry and wet, and number over six lakh specimens, including many unique and other type-specimens.

Indian Current Science Abstracts

INSDOC (Indian National Scientific Documentation Centre) informs us that, in answer to the long-felt need for a bibliographical periodical covering the entire scientific output of the country quickly and comprehensively, the Centre will start from January 1965 a monthly abstracting service under the title *Indian Current Science Abstracts* which will report work published by scientists in India and, as far as possible, scientific communications published abroad by Indian nationals. The annual subscription will be: in India Rs. 50, abroad £10 or $ 30. This new publication will take the place of the *Bibliography of Scientific Publications of South and South East Asia.* It will cover

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[1] Gazette of India Notification No. F.16-60/60-S.III, published in Part I, Sec. I of Vol. 28, dated 11th July, 1964, p. 238.

original articles, short communications, critical reviews, and informative papers published in scientific and technical periodicals, proceedings of scientific conferences, symposia, monographs, and other such literature, and will include patents and standards.

To make comprehensive coverage possible, co-operation is sought from all institutions, departments, societies, and individuals publishing scientific periodicals, reports, monographs, etc. INSDOC requests that copies of such publications, including reprints of papers published abroad, be sent regularly to *Indian Current Science Abstracts*, Indian National Scientific Documentation Centre, Hillside Road, Delhi-12.

Hornbill House

We hope soon to be installed in the Society's new premises at 'Hornbill House', Opp. Lion Gate, Apollo Street, in the compound of the Prince of Wales Museum of Western India, to which institution the site belongs and under whom the Society will hold as lessee. The bird figures in the name not with any ornithological significance but as a symbol of Nature generally. William appears on the title page of all the Society's publications and is already a familiar figure. For twenty-six years, from the time when he was taken as a nestling, he lived in the Society's rooms. In death, he is still to be seen as the father in the Great Hornbill family group in the Prince of Wales Museum.

XIV International Ornithological Congress, Great Britain, 1966

The dates for the Congress have been fixed as follows: Scottish Study Cruise—16-23 July 1966 (inclusive); Scientific Meeting in Oxford—24-30 July 1966 (inclusive). The Congress is open to all ornithologists over the age of 18 years.

The Study Cruise, on the 12,800 ton liner *DEVONIA* will leave from Glasgow, sail round the north of Scotland and its seabird islands, and end in Edinburgh. Parties will be landed on some of the islands. A special night train will convey members from Edinburgh to Oxford, where they will arrive on Sunday morning, 24 July.

Accommodation in Oxford will be arranged in University Colleges, or, if desired, a list of hostels will be supplied. After a formal opening on Sunday evening, 24 July, the rest of the week will be devoted to scientific meetings. In addition there will be exhibits, a whole day excursion, film shows, and a Social Centre for informal contacts.

Members may apply either for both the Oxford meeting and the Study Cruise, or for the Oxford meeting only. Application forms, with full details, can be obtained from: The Secretary-General, International Ornithological Congress, c/o Department of Zoology, Parks Road, Oxford, England. Applications for the Study Cruise will be dealt with in the order in which they arrive.

The costs of the Congress are as follows:

Congress Fee: Full Members—£10. (This entitles members to attend all functions and to receive the Proceedings); Associate Members—£7. (Wives or husbands of full members can register as Associate Members at this reduced fee, which entitles them to attend all functions, but not to receive the Proceedings.)

Cruise: From: *c.* £30 for dormitory passengers,
to: *c.* £75 for 1-berth cabin accommodation.

The train fare from Edinburgh to Oxford will be an additional cost.

Accommodation in Oxford: The cost, to be paid by individual members, will be approximately 50*s.* per day for full board in the Colleges. Hotels are, in general, more expensive.

The Elsa Wild Animal Appeal

In a letter written to one of our members Joy Adamson the celebrated author of BORN FREE and other books says: 'I am sending herewith *The Elsa Appeal Brochure* in the hope that you may be able to publish part of it in your *Journal* which may be of interest to the people in your country and stimulate their help.'

'The filming of BORN FREE is going splendidly, and I believe this film will make history and revolutionize the relationship between man and animals. We just returned from the Coast to film the lions in the area as I describe Elsa doing in BORN FREE. We took three lions there, hoping that ONE might oblige and enter the salt water, but all three were crazy about swimming, dived again and again through high breakers and the actors had a tough time in keeping up with the games of the lions. Then there were scenes when all rolled happily in the sand, and chased footballs along the beach—all so peaceful and natural. ALL THE TRAINING OF THE NINETEEN LIONS WE HAVE NOW ON THE UNIT SITE IS DONE UTTERLY BY KINDNESS AND PATIENCE AND THE RESULTS ARE STAGGERING. It proves that not only Elsa but all predators and animals if well fed and unprovoked, respond to a treatment of affection with mutual feelings.'

The Elsa Wild Animal Appeal aims to bring home to the people the need to save from extinction many species of wild life in Kenya and East Africa. A sum of £110,000 is needed immediately. The money will be used for financing rescue teams and combating poaching and to develop reserves which have been donated by Africans until they become self-supporting. Donations can be sent to The Elsa Wild Animal Appeal, c/o Charities Aid Fund, 26 Bedford Square, London W.C. 1.

PRINTED AND PUBLISHED BY V. M. PHILIP AT THE DIOCESAN PRESS
10 CHURCH ROAD, VEPERY, MADRAS—10-6-1965. C2399
EDITORS: H. SANTAPAU & ZAFAR FUTEHALLY

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The Society will gratefully accept back numbers of the *Journal,* particularly numbers prior to Vol. 45, from members who may not wish to preserve them.

TERMS OF MEMBERSHIP

Life Members pay an entrance fee of Rs. 5 and a life membership fee of Rs. 500.
Ordinary Members pay an entrance fee of Rs. 5 and an annual subscription of Rs. 30.

The subscription of members elected in October, November, and December covers the period from the date of their election to the end of the following year.

MEMBERS RESIDING OUTSIDE INDIA

The terms are the same for members living outside India. Such members should pay their subscriptions by means of orders on their Bankers to pay the amount of the subscription, plus postal registration (Rs. 2.50) if required—in all Rs. 32.50—to the Society in Bombay on the 1st January in each year. If this cannot be done, then the sum of £2-10-0 should be paid annually to the Society's London Bankers—The National & Grindlays Bank Ltd., 26 Bishopsgate Street, London, E.C. 2.

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